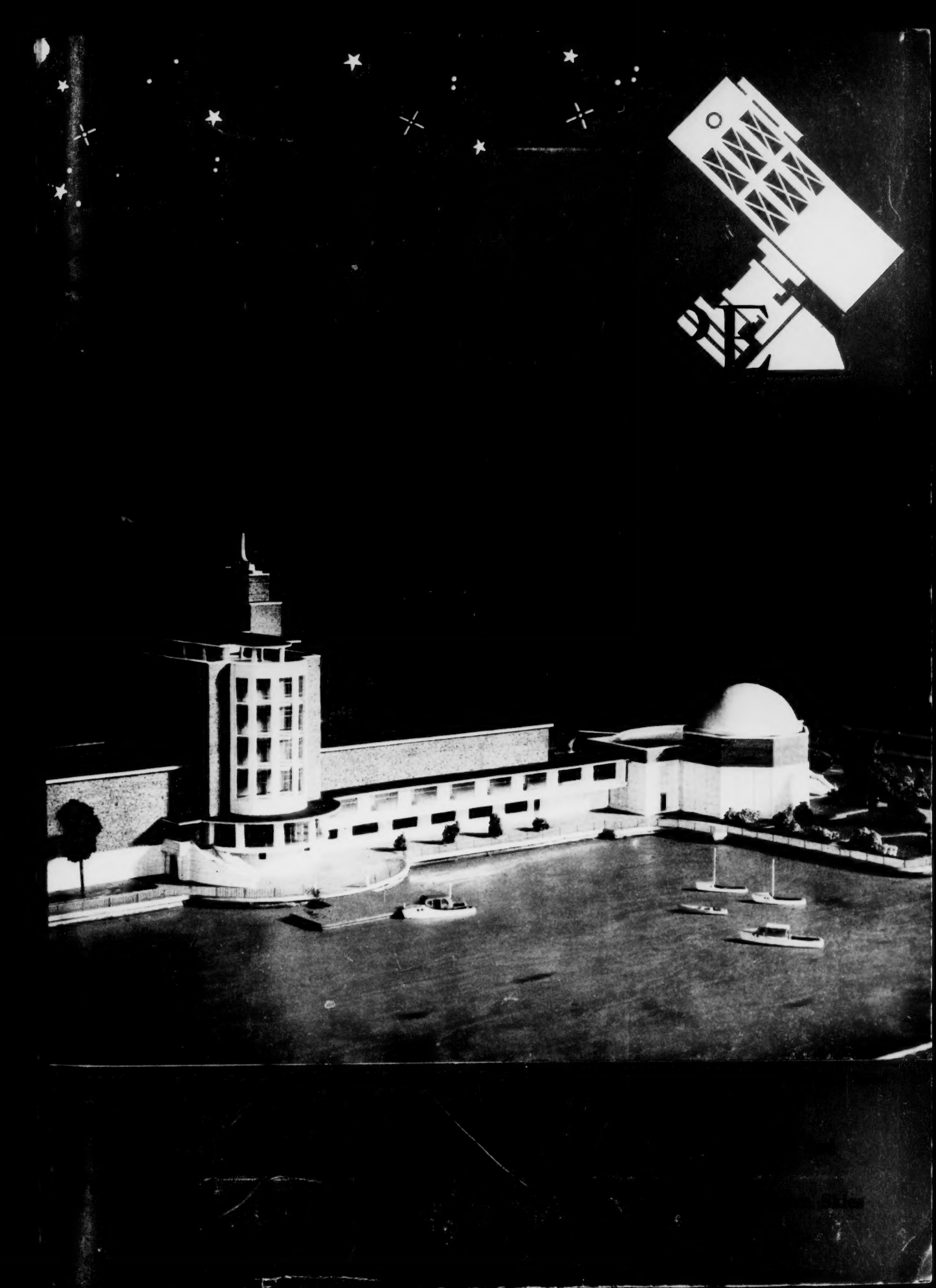

## LETTERS

Sir:

At the suggestion of the Ottawa Centre, at its annual meeting on January 12th the Royal Astronomical Society of Canada passed the following resolution, which has now been transmitted to the proper authorities in the Canadian government:

"That this society go on record as urging the Canadian Government to designate the area involving the recently explored crater in Ungava as a National Park, or to take other appropriate steps to preserve this crater as an object of scientific interest. . . ."

We are making some progress with this project, but it would help us to get quicker results if some of your readers cared to support the demand for preservation of the crater site by sending letters, or resolutions of societies, to the government of the Province of Quebec, or to me for forwarding.

J. HARGREAVES
6 Osborne St.
Ottawa, Ont., Canada

ED. NOTE: Chubb Crater in Quebec, a possible meteorite crater, is described by Dr. V. B. Meen, director of the Royal Ontario Museum of Geology and Mineralogy, in the **Journal** of the Royal Astronomical Society of Canada, XLIV, 5, September-October, 1950.

Sir:

The back-cover picture of the February, 1951, **Sky and Telescope** is most interesting, as this sketch shows. So that's where he is! and side kick too!

MR. AND MRS. MARION I. GRAY
3168 Glenwood Ave.
Toledo 10, Ohio


**THE INDEX TO VOLUME IX**

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Sky and TELESCOPE



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## The Editors Note . . .

SHIGETSUGU FUJINAMI, associate professor of the Astronomical Institute, University of Kyoto, Japan, wrote us on January 22, 1949, "I would like to publish a Japanese edition of your magazine, **Sky and Telescope,** for astronomical lovers of Japan." He proposed that 80 per cent of the Japanese edition be translated from our pages and that the remainder be original "Japanese descriptions." Needless to say, we were pleased to support his plan.

After many months spent in filing official forms and in lining up his manufacturing program under difficult conditions, Professor Fujinami has achieved the publication of two numbers, for November-December, 1950, and for January-February, 1951. The third issue was scheduled for publication in the middle of March. Each printing is 3,000 copies, the magazine selling at bookstores for 100 yen; already there are more than 200 regular subscribers to the Japanese bimonthly edition.

Editor Fujinami has evidently paid careful attention to the material and scientific standards that we try to maintain for this publication. In format, including front and back covers, color on cover, number of pages, and paper stock, the Japanese edition is strikingly like the American original. The illustrations and authors' names are, of course, very familiar to us. But there the resemblance ceases, as every bit of text, except an occasional word, is in the language of Japan. It is most interesting to see what the "Wellesley Convention" story (**Sky and Telescope,** October, 1950) looks like in Oriental characters. Some of the star charts are specially drawn in Japanese.

Readers interested in this project, or in subscribing to the Japanese edition, may write to the Sukai Editorial Room, Department of Astronomy, University of Kyoto, Sakyoku, Kyoto, Japan.


VOL. X, NO. 7 — MAY, 1951
Whole Number 115


## CONTENTS

COVER: Part of a model of the new building and planetarium for the Boston Museum of Science, at Science Park, Boston, Mass. It is located at the eastern end of the Charles River Basin, between North Station in Boston and Lechmere Square in Cambridge, on property of the Metropolitan District Commission. At present the east wing, between the tower and the planetarium in the model, is built and open to the public. The next projected unit is the Hayden Planetarium and Morse Auditorium. Boston Museum of Science photograph. (See page 159.)


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BACK COVER: The central region of the Pleiades cluster, showing the nebulosity enshrouding some of the principal stars. The photograph was taken by H. W. Babcock with the 36-inch Crossley reflector, two-hour exposure, January 13, 1939. West is at the top, north at the left; scale about one millimeter to 20.1 seconds of arc. Lick Observatory photograph. (See page 164.)


SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions, and to Latin-American countries; $7.00 for two years. Add $1.00 per year for Canada and for all other foreign countries, making the total subscription $5.00 per year and $9.00 for two years. Canadian and foreign remittances should be made in United States currency. Single copies, 35 cents. Circulation staff: Betty G. Dodd, manager; Nancy R. Bolton; Virginia K. McAuliffe.

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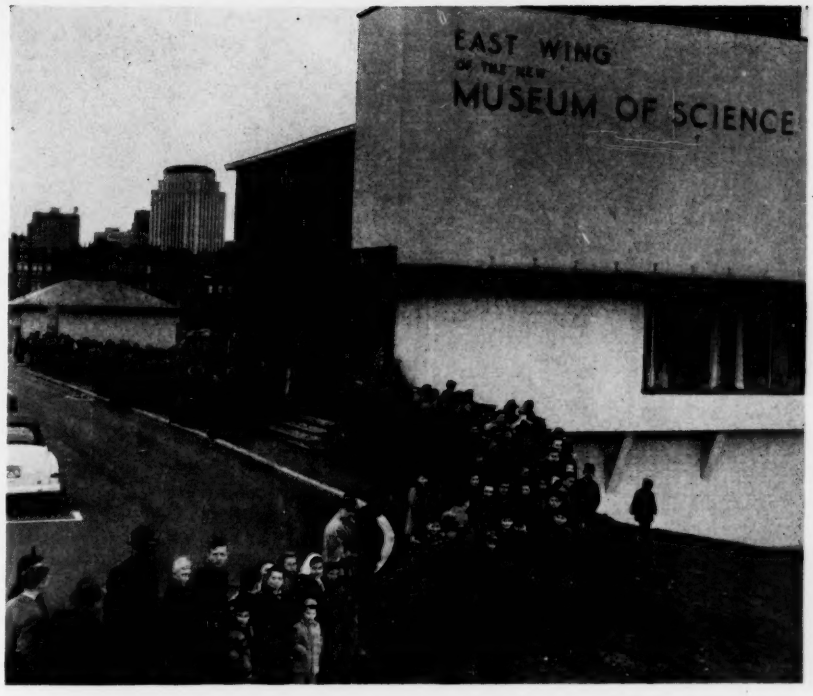



**On opening day of the east wing of the new museum, thousands of persons of all ages came to view physical-science and live-animal exhibits.**

# Boston Museum of Science

IN FEBRUARY, Bradford Washburn, director of the Boston Museum of Science, announced that the construction of the largest planetarium in New England would commence in the near future. A gift toward the planetarium of $250,000, made last June by the trustees of the Charles Hayden Foundation, has been more than matched by other donations procured by the museum's development fund under the chairmanship of George P. Gardner, Jr. The sum of $100,000 was given for the Edward S. Morse auditorium, a lecture hall seating 400 persons, to be located on the lower floor of the planetarium building.

The planetarium will be of relatively moderate size, seating about 225 persons or more, with its interior dome 55 feet in diameter. The illusion of the sky is expected to be as good as that obtained with larger domes, and the cost of construction and operation will be considerably less. A roof deck of good size will permit observations with telescopes. Science Park, located on the Charles River dam at the eastern end of the Esplanade, has a favorably low horizon and is well protected from the bright lights of Boston.

Rising prices have upped the estimated cost of the planetarium building by $100,000, and this amount with another similar sum for the projector and equipment for the building must still be raised. The funds will be sought while building is in progress.

The planetarium, which should be built in about a year, will adjoin the east wing of the Boston Museum of Science and be connected to it by a glassed-in promenade overlooking the Charles River basin (see the front cover).

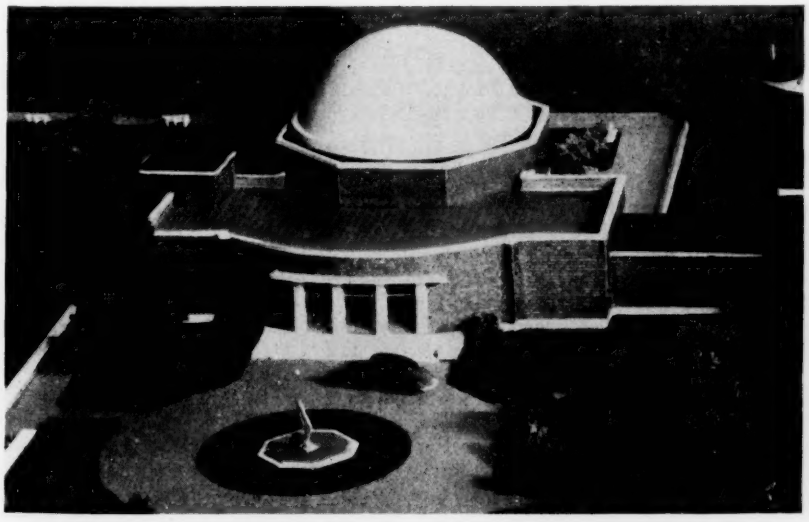
On March 13th, the $750,000 east wing was opened to the public. It is the first unit, one third of the projected central museum building, and it contains 14,000 square feet of exhibit space. At present, a curved wall divides the first floor into three main areas devoted to science and industry, transportation, and natural history. A stage, 10 by 18 feet, is located at one end of the natural history area for live-animal and other special demonstrations.

In a modernistic setting on the upper floor, the Little Planetarium continues in operation. Twenty thousand people attended lectures in this 50-seat planetarium, which has a Spitz projector, while it was part of the temporary museum during construction of the east wing. Its 18-foot dome is that originally built for the traveling planetarium (see *Sky and Telescope*, January, 1949, page 66).

A six-foot model of the uranium atom of atomic weight 235 is one of the unique displays in the Museum of Science. It shows the U235 nucleus with its protons and neutrons, and encircling it are the 92 ring electrons. The electrons are made of wood fastened to stainless steel wire orbits and coated with luminous paint that glows under ultraviolet illumination.

Associated with the uranium atom model is a 42-inch model of a cyclotron, lent by Massachusetts Institute of Technology, and a cloud chamber in continuous operation, revealing the tracks of cosmic rays and of particles from radioactive substances. One of the exhibits with which special demonstrations are given is a Van de Graaff generator, producing 250,000-volt discharges of static electricity. There is also an Oudin coil that produces 500,000 volts of alternating current.

Some of the first-floor illumination is provided by the 10-foot lens from the historic Navesink lighthouse in New



**A closeup view of the other side of the model on the front cover shows the entrance to the planetarium and the spacious observing roof.**

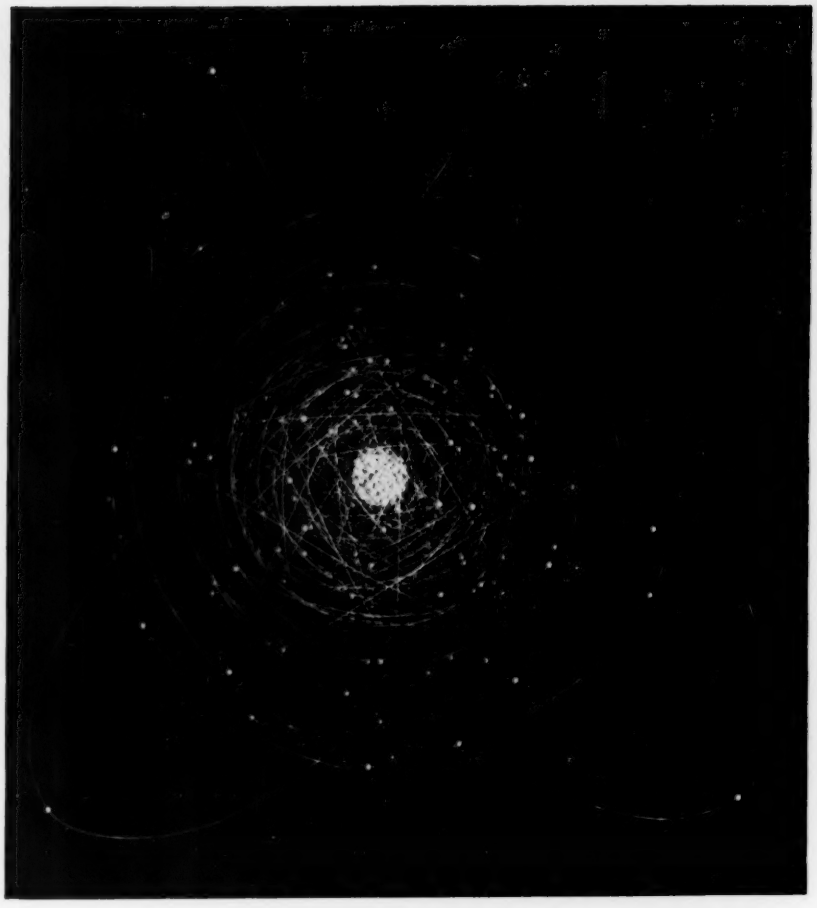
York Harbor, of 9,000,000 candlepower. It revolves on the original French mounting approximately once per minute, flashing every 35 seconds. A 14-inch porthole in the base allows a view of the huge gears that drive the four-ton light, which is on a long-term loan from the U. S. Coast Guard. On display near the light are authentic replicas of ships dating back to 3000 B. C., and working models of marine engines.

Of special interest in science history are dioramas of Swiss lake dwellers and of Neanderthal man. First of its kind is a model that shows 2,000 Egyptians building a pyramid, the work of a lifetime.

Attendance at the east wing already indicates the tremendous interest in science among adults and children in the Boston area. In the first two weeks, 9,212 adults and 6,175 children paid admissions of 30 cents and 14 cents respectively (including tax), and on the weekend of March 17-18 the total attendance was 5,578. Although an extra charge of 30 cents is made for the planetarium, it has been sold out for almost all regularly scheduled demonstrations.

As the visitor enters the new museum, he may read the plaque in the lobby bearing the following words by Albert Einstein:

"It is of great importance that the general public be given an opportunity to experience — consciously and intelligently — the efforts and results of scientific research. . . . Restricting the body of knowledge to a small group deadens the philosophical spirit of a people and leads to spiritual poverty."



**In this large model of the U235 atom, built by Leigh Gibbs of the museum staff, some of our mathematical concepts of the atom's interior are represented schematically, such as the "orbits" of the ring electrons.**

# TERMINOLOGY TALKS

J. Hugh Pruett

*Ancient Years*

Historical records indicate that the ancient peoples had years of various lengths. They found it more convenient to go by the phases of the moon than by the positions of the sun among the stars. The first appearance of a "thin slip of a new moon" in the western twilight was easily observed, and the interval of time between this and the next such first appearance was used as the month. To compound 12 months into a year was the simplest of operations.

But 12 lunar months of alternating 29 and 30 days (average 29½ days) give a year of only 354 days. Various nations used such years, but as they were not long enough, the seasons kept "going ahead" among the months. Such years were about 11 days too short, so over a period of 33 years, any season would occur during all the months of the year. Should we now suddenly go on such an unscientific year, before too long the hottest days of summer would be with us in mid-northern latitudes when our calendars told us it was Christmas. Therefore, many countries added a 13th month every two or three years.

The Mohammedan nations seemingly still use this 354-day year, but since most of them are located where there is no great change from one season to the next, the resulting confusion is not serious. Stokley has remarked that if a Mohammedan says he is 68 years old, his statement should be taken with a bit of reserve. A slight calculation will show that his age is only 66 by our standards.

The late James Henry Breasted, the noted historian, has told us that one ancient nation actually used a fairly accurate length of year. The Egyptians started the 365-day year possibly as far back as about 4236 B.C., and for over 3,500 years they were the only people to use it. But even this is not astronomically exact, since the year is more nearly equal to 365¼ days. The Egyptians would lose a full year after about 1,460 years, but the loss would not be serious in a human lifetime. It is said that King Darius tried to introduce the Egyptian calendar into his empire in the 6th century B.C., but failed.

As the Christian era was approached, astronomical information increased and some attempts were made to correct the length of the year. Finally, in 46 B.C. Julius Caesar, on the advice of the astronomer Sosigenes, discarded all consideration of the moon and decreed a year 365¼ days in length. To handle this, it was arranged that three years should contain 365 days; and every fourth year, 366 days. This was the origin of leap year, despite the general opinion among some that such years are a social institution originated to give those of the feminine persuasion certain advantages.

*Sidereal Year*

It is often stated that our common year is the time required for the earth to make one complete trip around the sun. This lacks accuracy by about 20 minutes. The "round-trip" year is the *sidereal,* or star, year. It is the time for the apparent movement of the sun — the "reflection" of the earth's movement around the sun — from a certain star along the ecliptic back to that star again. Its length is known to be $365^d\ 6^h\ 9^m\ 10^s$ of mean solar time.

# NEWS NOTES

By Dorrit Hoffleit

### *NEW RULING ENGINE*

"The growing scarcity of optical quartz for use as prisms in scientific and in industrial spectroscopic equipment portends a growing demand for diffraction gratings," says Dr. John Strong, Johns Hopkins University, in the January *Journal* of the Optical Society of America. Moreover, existing ruling engines cannot meet these demands, nor will replica gratings always solve the problem where larger gratings are needed. Hence, Dr. Strong, aided by the Office of Naval Research, has built a two-screw engine which is an improvement of the single-screw Rowland type.

In the Rowland type the cutting diamond reciprocates in ways across a grating blank which is driven by the screw. The new design causes the grating blank to reciprocate beneath a diamond, which is supported and moved slowly by the two parallel screws. "In the manner of operation the Rowland engine resembles a tool room shaper whereas our new engine resembles a tool room planer."

"Fanned" lines are not produced by the new engine, and it is designed for immunity to temperature, friction, and wear. The present pilot model machine can rule 14,000-line gratings in sizes up to six inches in about 67 hours.

### *RADIO FROM GALAXIES*

Since the discovery by scientists at the Jodrell Bank Experimental Station of radio energy from the Andromeda nebula (*Sky and Telescope,* March, 1951, page 116), others at the Cavendish Laboratory, Cambridge, England, have independently discovered the radiation from M31 and, in addition, from three other galaxies: M33 in Triangulum, M51 in Canes Venatici, and M101 in Ursa Major. The last two are believed to be three or four times as far away as are M31 and M33.

### *TRANSATLANTIC BALLOONS*

Last year two high-altitude balloon flights made headline news. Launched at Holloman Air Base at Alamogordo, N. M., one balloon was carried eastward by high-velocity winds. It was tracked by following aircraft as far as Georgia, where the pursuit was abandoned, but was found two days later on a snowbank at Myrdal, Norway, after a trip of over 6,000 miles. The balloon had remained aloft from 50 to 52 hours. A similarly released balloon landed in northeastern Algeria after a two-day flight.

These meteorological balloons are described in the *Transactions* of the American Geophysical Union by W. D. Murray, C. S. Schneider, and J. R. Smith, of New York University, working under an Air Force contract. Seventy feet in diameter, each balloon can remain at a pre-selected level in the atmosphere, up to 120,000 feet, for 48 hours. As much as 200 pounds of equipment can be carried up to 90,000 feet.

Sampling of upper-air data can be more extensive than with rockets or other means and hence more representative. Also, the instruments carried need not necessarily have rapid response, and therefore they may be less costly.

### *NOVA IN SAGITTARIUS*

Harvard Announcement Card 1118 announces the discovery on March 7, 1951, of a 9th-magnitude nova in the constellation Sagittarius in the position $17^h\ 41^m\ 45^s$, $-20°\ 37'\ 36''$ (1855). It was found by Dr. G. Haro, assistant director of Mexico's National Astrophysical Observatory at Tonanzintla, Puebla. In April last year, Dr. Haro found a faint nova in Hydra, and in August he discovered one of magnitude 7.5 in Scorpius.

### *1951 IAU MEETING CANCELED*

The executive committee of the International Astronomical Union has decided to cancel the general assembly of the IAU in Leningrad and the Stockholm symposia, due to present uncertain political conditions, it has been announced by Dr. B. Stroemgren, secretary general of the union. The assembly had been scheduled to be held in Leningrad, U.S.S.R., in August this year. Professor Stroemgren emphasized the fact that the other activities of the union will continue without interruption. The executive committee has not yet decided the time of the next general assembly.

### *MOREHEAD DIRECTOR RESIGNS*

Dr. Roy K. Marshall, director of the Morehead Planetarium and professor of astronomy at the University of North Carolina, Chapel Hill, since January, 1949, resigned his position on March 1st to return to Philadelphia and devote full time to radio, television, and newspaper work.

Dr. Douglas Duke has been named acting chairman of the astronomy department and is the planetarium's astronomical advisor. W. D. Bulloch is the producer, and A. F. Jenzano is manager of the planetarium.

Since its opening in March, 1949, there have been over 250,000 paid visitors to the Morehead Planetarium. Dr. Duke and the university will be hosts to the Astronomical League general convention on September 1-3 of this year.

### *ELECTROPHOTOGRAPHY*

The Signal Corps Engineering Laboratories sponsored a camera for taking pictures on the spot that won't fog even in active atomic radiation areas. *Ordnance* (March-April, 1951) reports that the new camera produces a finished 4-by-5 picture within two minutes after the shutter is snapped. Moreover, the same plates can be used over and over merely by wiping off the image after prints have been made.

In the process, light is recorded on a selenium-coated metal plate that has been sensitized by an electric charge. Light striking the plate produces an invisible electrical image. If finely ground charcoal or anthracite coal powder is blown on the plate, it sticks wherever there is an electric charge — the more electricity, the more powder sticks. Paper or other material coated with an adhesive layer such as rubber cement is pressed against the plate to make the final print, which is protected by pressing a clear transparent plastic film over it.

The camera itself uses an ordinary lens and shutter. The speed for the plate is about the same as for orthochromatic black-and-white film. No darkroom is necessary.

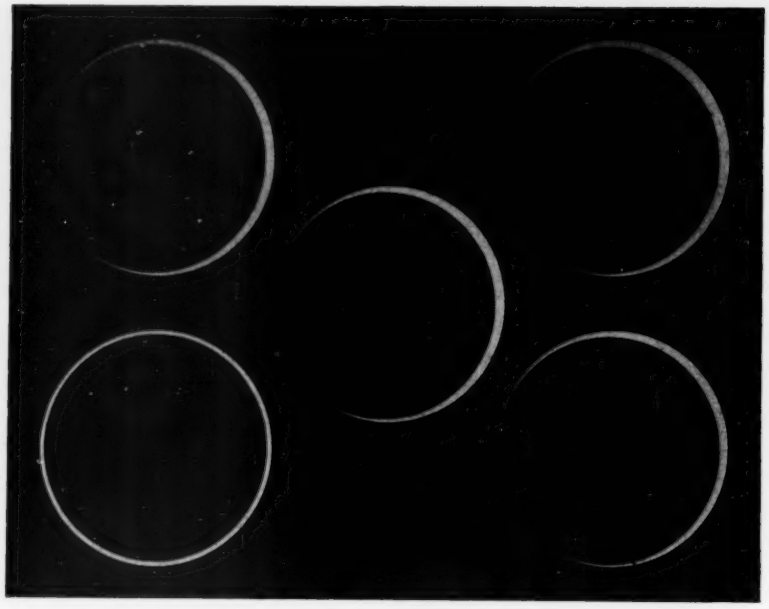
### *"NEWS REPORT"*

*News Report* is a new publication by the National Academy of Sciences and the National Research Council. It is a bimonthly bulletin "designed to report current activities of divisions, boards, committees, and other established groups within the organization, and to record news of affiliated Societies and developments in the field of international science." Vol. I, No. 1, issued for January-February, 1951, has a foreword by Detlev W. Bronk, president of the National Academy, and an article on scientific manpower by M. H. Trytten, director, Office of Scientific Personnel. Subscriptions to unaffiliated persons are $2.00 per year, from News Report, 2101 Constitution Ave., Washington 25, D.C.

### *FRANK S. HOGG MEMORIAL*

In memory of Dr. Frank S. Hogg, who died early this year, a scholarship in astronomy at the University of Toronto is being established. The memorial is particularly fitting, as one of Dr. Hogg's chief interests was his students, and the fund will aid students beginning astronomical careers at the only Canadian university offering postgraduate work in astronomy.

The Royal Astronomical Society of Canada is supporting the plan, in co-operation with the university and the staff of the David Dunlap Observatory. Individuals and organizations may make contributions payable to the University of Toronto, marked Frank S. Hogg scholarship fund.



**The ring eclipse of May 26, 1854, was recorded by the daguerreotype process.**

# The September Annular Eclipse

By Paul W. Stevens, *Rochester Astronomy Club*

IN MOST AREAS where it will be seen in the United States, the solar eclipse of September 1, 1951, will begin before sunrise. The exception is in eastern Maine, where first contact will not take place until a few minutes after sunrise. For those who cannot travel to the path of the annular phase, the novelty of a rising crescent sun should add a bit of sparkle to the beginning of the Labor Day weekend.

*Path of the Annular Phase*

The annular phase will be seen in North Carolina and Virginia, as shown on the sketch map of important towns and mountains. According to the *American Ephemeris,* the axis of the moon's extended shadow first touches the earth at longitude 80° 56′ west, latitude 36° 19′ north, near the town of Elkin, N. C. This is a little east of the Blue Ridge Parkway and northwest of Winston-Salem. However, this prediction assumes the observer to be at sea level, and does not take into account the refraction of the atmosphere nor the size of the solar disk. Accordingly, a mountain view near this point will disclose the rising sun at least five minutes before the annular phase begins.

A complete ring of sunlight should be seen after sunrise from points as far west as Deep Gap on the Blue Ridge Parkway. Grandfather Mountain and Rendezvous Mountain State Park are recommended as suitable vantage points from which to chance such a view.

An excellent location from which to observe the annular phase a few minutes after sunrise is Pilot Mountain, 60 miles east of Deep Gap. Of this, the State Department of Conservation and Development mentions: "The Pilot rises 1,600 feet above the countryside and is a source of constant wonder to strangers passing on the Transcontinental Highway near its base. A good road goes up to the base of the stone cap, and from there a guard-railed stairway provides safe, easy ascension to the top. The trip is well worth while, for a beautiful panorama of northwestern North Carolina unfolds on every side, and on a clear day even the buildings of Winston-Salem and Greensboro are visible on the eastern horizon." About 10 miles farther east is Hanging Rock State Park.

All the places described above are very close to the central line. Farther east, this line crosses into Virginia and then, after skirting Norfolk, passes out to sea between Cape Henry and Cape Charles. There, on the coast, the sun will be at an altitude of four degrees when the moon is centered on its disk. By a remarkable coincidence, the central line goes through a little town named Eclipse on the shore of Hampton Roads. Perhaps this was named as a result of observance of an eclipse in this vicinity.

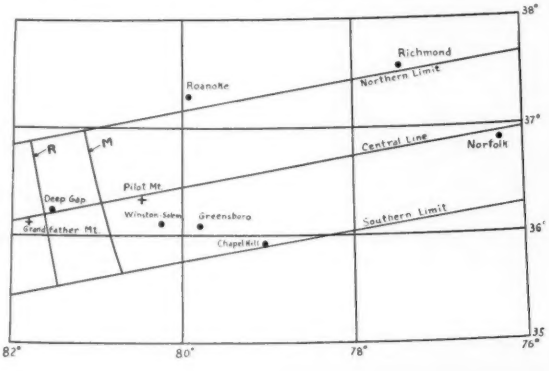
The width of the path of the annular phase is about 95 miles. The northern limit passes below Richmond, while the southern limit is just below Chapel Hill, site of the convention of the Astronomical League.

The centers of the earth, moon, and sun determine a plane, and the intersection of this plane with the earth's surface is a great circle, such as navigators follow as the shortest distance between two ports. The angle which this circle makes with any given meridian is the azimuth of the moon and sun at that particular point on the globe.

When the axis of the moon's shadow first strikes the earth during any central solar eclipse, it traces a course which is tangent to the great circle defined above. In the present instance, the bearing of moon and sun will be 79° (11° north of east). During its first 78 seconds of life, the central line travels 577 miles, but deviates only nine miles northward from the great circle.

In the sketch map, the line marked *R* is perpendicular to the central line. It is the locus of all points, within the annular belt, at which the sun is rising at the time of second contact of sun and moon as seen at the station where the lines intersect. Allowance has been made for the semidiameter of the sun and for atmospheric refraction, but not for the dip of the horizon.

The line marked *M* is plotted from the data in the *American Ephemeris.* It is the locus of points at which mid-eclipse occurs at "sunrise" without compensation for the size of the solar disk or the refraction of the atmosphere. It is curved because of the circular shape of sun and moon. The tangent to curve *M* intersects the central line obliquely. The two would meet at right angles if the apparent motion of the moon across the sun were in a vertical direction as one faces the rising sun. However, there will be a slight drift of the moon




**The author's sketch map to show the limits within which the annular phase of the eclipse can be seen. The lines marked "R" and "M" are described in the text.**

from right to left, as well as the principal motion from top to bottom as it advances over the solar disk. The result is that mid-eclipse at "sunrise" occurs a little earlier on the southern limit and later on the northern limit than it does on the central line.

THERE are a number of factors contributing to make this an unusually interesting eclipse, not the least of which is the time of year. Even though lacking the glamour of a total eclipse, it will be just as dramatic for the keen observer in this country, chiefly because it takes place at sunrise.

*Zodiacal Light*

In the Northern Hemisphere, the orientation of the ecliptic is most favorable for observing the pearly zodiacal light in the mornings of late summer and early fall. In North Carolina, the ecliptic will be inclined 70 degrees to the horizon at the break of dawn when the zodiacal light appears brightest. It will be of interest to compare brilliance and texture of the zodiacal light with the faintest parts of the Milky Way, which at that time will arch high in the east across the ecliptic.

*Visibility of Stars*

It will be worthwhile to observe the dawn and rising sun the day before the eclipse. One might profitably watch the constellation Orion, high in the south, and note to the nearest minute the times when its stars disappear from view to the unaided eye. For rather faint stars, the little triangle in the warrior's head is suggested, while the belt is a brighter grouping that will remain visible longer. After these become invisible, one could note when Betelgeuse and Rigel vanish against the growing twilight.

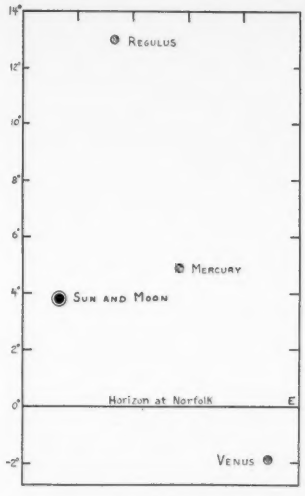
On the day of the eclipse, the break of dawn will occur a half hour before the moon makes first contact with the solar disk, and for a while the increase in sky brightness will follow the normal pattern. As the eclipse progresses, however, there will come a time when the brightness reaches a maximum and thereafter diminishes. Where the rising sun discloses the moon centered upon it, many of the brilliant stars of winter evenings should be visible. The observations on the Orion group should therefore be repeated, to see whether any of its stars that disappear may reappear before sunrise. A keen eye may follow Rigel continuously until the end of the annular phase.

*Regulus*

The heliacal rising of the 1st-magnitude star Regulus takes place about September 1st, as was well shown by an experience of the writer in 1948. On the afternoon of August 31st in that year, the sky over Rochester was exceptionally clear. Since the planet Venus was near its greatest western elongation, it was a fine opportunity to see how close to the horizon it could be detected a matter of hours before sunset.

Venus was visible to the unaided eye until its altitude had decreased to about 10 degrees. Then with an 8-power telescope, of objective diameter two inches, it was possible to follow the planet until it disappeared behind some trees that were perhaps three degrees above the horizon. This was of special interest at the time as it was the 16th anniversary of the 1932 total eclipse. Accordingly, Venus and the sun were in virtually the same positions in the sky as they had been on August 31, 1932.

Clear skies remained over Rochester all night, so the next morning provided an excellent chance to see if a glimpse




**The positions of Regulus and Mercury relative to the sun at the time of the annular eclipse. Venus will be below the horizon at Norfolk.**

of Regulus were possible. Saturn was approaching conjunction with the star and was detected with the unaided eye. The star, close at hand to the east and fainter, was seen through 6 x 30 binoculars. An observer on a hilltop might have seen it without optical aid.

An interval of one Metonic cycle elapses between the total eclipse of 1932 and the annular eclipse of September 1, 1951, so the distance of Regulus from the sun will be the same as before. Their relative positions will be as shown in the diagram. During early dawn, one should watch for the star through binoculars. Once detected, see if Regulus remains visible through the annular phase. Some of the other stars in the Sickle of Leo should be easily seen in the dawn, and may be used as guides to the location of Regulus.

Those who carry out the observing program suggested for the day before the eclipse should be rewarded with a fine view of Regulus and the crescent moon. The latter will be 12 degrees from the sun and will show about as slender a crescent as can ever be observed. Separated by four degrees, moon and star will be simultaneously visible within the field of view of a prism binocular. Later in the day, the moon will occult Regulus, but the phenomenon can be seen only within a narrow twilight zone in the Pacific Ocean.

*Corona and Prominences*

One does not usually look for these during an annular eclipse unless he has a coronagraph or a spectrohelioscope. However, granted exceptional atmospheric conditions, it might be possible to see them at this sunrise eclipse with simple equipment.

To do this, an observer must be stationed in North Carolina where the sun will appear on the horizon just before the annular phase begins. While the upper limb is still covered by the moon and the lower limb is yet beneath the horizon, it may be possible to view the corona and prominences. In a hazy sky, of course, scattered sunlight would obliterate them.

*Mercury and Venus*

These two planets will be near inferior conjunction, but at considerable latitudes south of the sun. Thus, they will show very narrow crescents and be a challenge to observers with small telescopes during the eclipse. Their positions relative to the sun and the horizon at Norfolk are plotted in the diagram.

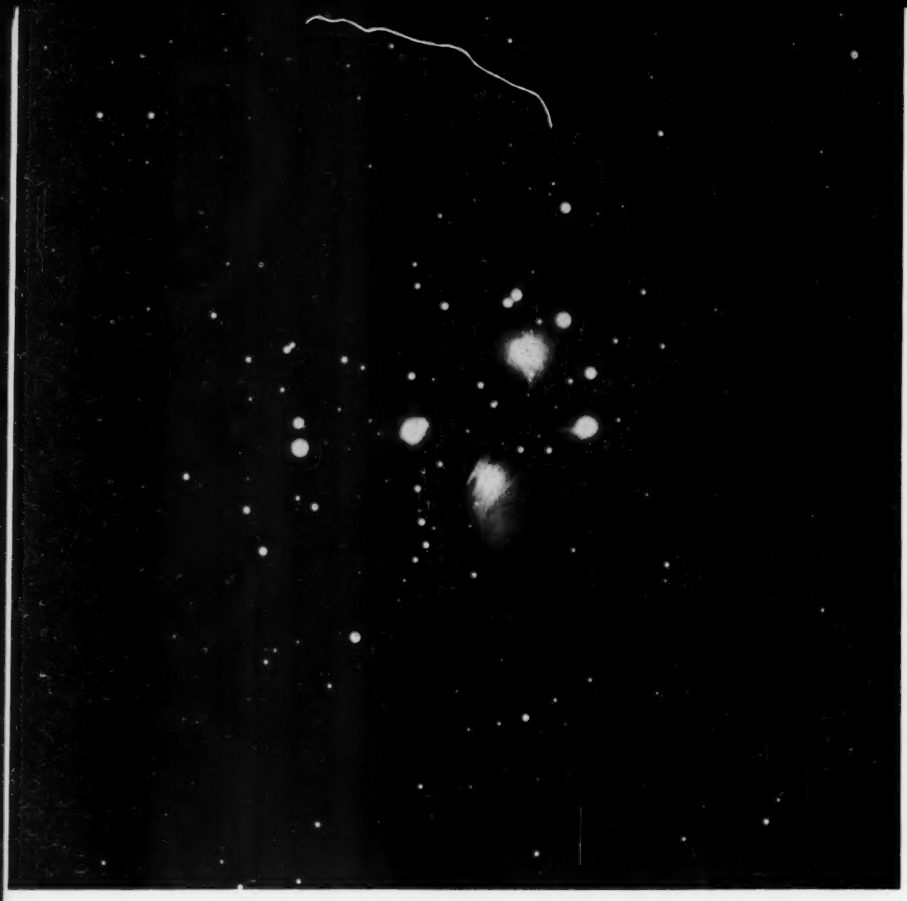
Since Mercury rises a little ahead of the sun, a clear atmosphere may disclose it wherever one can see the annular phase. In order to see Venus at that time, however, one will have to be out on the Atlantic Ocean. It will rise shortly after third contact, however, before the increase in solar illumination becomes appreciable.

At midday, throughout the convention of the Astronomical League, the brilliant planet will test the performance of all instruments. The sun will then be at an altitude of 63 degrees, with Venus nine degrees south of it. It will be fun to search out the slender crescent as we gather at Chapel Hill to exchange stories of the eclipse.

*Jupiter*

At sunrise, the giant planet will be at an altitude of 32 degrees a little south of west. When favorably situated, Jupiter is visible to the unaided eye when the uneclipsed sun is as much as 10 degrees above the horizon. Therefore, it should remain a conspicuous object throughout the period of dawn on September 1st. An observer with a spotting scope or binoculars might carry out on the Jovian satellites the same type of experiment suggested above for the stars.

*(Continued on page 167)*



**The region of the Pleiades cluster, members of which have been identified well beyond the limits of this field. North is at the top. Lick Observatory photograph by Vasilevskis with the 20-inch Ross-type photographic refractor.**

# The Distance of the Pleiades

By Otto Struve, *Berkeley Astronomical Department*
*University of California*

MAY IS THE MONTH in which the sun passes among the stars of Taurus, but in another month the Pleiades will be seen rising ahead of the sun in the morning sky. To the naked eye the cluster appears as a nebulous patch of light, and closer inspection reveals six distinct stars, with the 3rd-magnitude Alcyone ($\eta$ Tauri) in the middle.

The Pleiades were well known in ancient times. They have been recorded by the Chinese, the Hindus, the Chaldeans, and the Greeks. They are described in the Bible, and the Romans composed songs about them.

A great many of these ancient stories mention the existence of seven stars — the seven sisters, or the seven pigeons, or the hen with her six chickens — but no one knows whether the old tradition of the "lost Pleiad" refers to a real star which has become fainter in recent centuries or merely represents an expression of the fact that the number of easily seen naked-eye stars is one short of the mystical number seven.

It is recorded that Kepler's teacher, Maestlin, in 1579, charted 11 stars, as did also the astronomer Heyden in 1611. Even in the 13th century the Arabian astronomer Kazwini suspected that there were a number of faint stars in addition to the six bright ones.

The best telescopic view of the Pleiades is obtained with an instrument of wide field — even a finder will do. A large number of stars, bright and faint, crowd around the six naked-eye stars and form, all together, the most remarkable galactic cluster in the heavens.

It has been estimated that more photographs of the Pleiades have been taken by astronomers than of any other object in the stellar universe. Similarly, it is no exaggeration to say that more refined observations of all kinds have been made of the Pleiades than of any other distant object. In 1610, immediately after the discovery of the telescope, Galileo started the ball rolling with a list of 36 stars in this cluster. In 1665, Hooke observed 76, and at present about 250 stars are known to be members, some of the faintest being of apparent magnitude 17 and identified from the uniformity of their motions by A. van Maanen at Mount Wilson.

In recent times, the principal advances in the study of the Pleiades have been made by E. Hertzsprung, whose Darwin lecture for 1929 at the Royal Astronomical Society in London remains one of the great classics of astronomy (*Monthly Notices* of the R.A.S., *89*, 660, 1929), and whose catalogue of the members of the cluster is the basic source of information for all modern investigations; by R. J. Trumpler, whose brilliant sketch in a Morrison lecture at San Francisco, in 1943, has provided some of the material for the present article (*Publications,* Astronomical Society of the Pacific, *56*, 65, 1944); and by L. Binnendijk, who in 1946 discussed his own and all previous determinations of the brightnesses of the cluster's stars, in photographic as well as in visual light.

Among the many interesting problems that the Pleiades have presented, one of the most thorny is the determination of their distance. Distance measurements are always difficult, requiring much effort — and even greater skill — in recognizing and eliminating various errors of measurement. But in the case of the Pleiades the situation seems to be even more complicated. What at first appeared to be a relatively unimportant difference in the results obtained by different methods begins to look like a clue to some important new discovery.

There are, essentially, two groups of distance-measuring methods: the geometrical ones, which make use of the solution of various kinds of triangles, in which one of the sides is known in linear measure, while the angles have been directly measured at the telescope; and the photometric and spectroscopic methods which involve the comparison of a Hertzsprung-Russell diagram of the cluster with a similar diagram for a group of stars whose distance is already known.

### *Geometrical Methods*

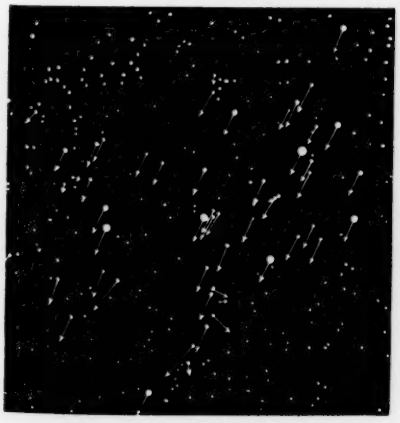
The ordinary, *trigonometric* method of measuring the annual displacements of the star positions with respect to more distant background stars has given no reliable results for the Pleiades. Thus, H. L. Alden, at the Leander McCormick Observatory, from 22 stars found a parallax of 0.009 second of arc, with a probable error of 0″.004, while J. H. Pitman, at the Sproul Observatory, from nine stars found 0″.017 with a probable error of 0″.006. The discrepancy is not surprising. It simply means that the distance — of the order of 100 parsecs or roughly 300 light-years — is so close to the limit of the trigonometric method that unavoidable accidental and systematic errors constitute a large fraction of the entire parallactic displacement.

Another method is based upon the observed orbital motions of several physical

double stars within the cluster. The result is known as a *dynamical parallax,* and the method is described on page 692 of *Astronomy* by Russell, Dugan and Stewart (1938). Kepler's third or harmonic law is a fundamental relation between the semimajor axis of the orbit in kilometers, the period of the binary in years, and the masses of the two component stars in terms of the mass of the sun. From the spectral types and relative apparent magnitudes, we can make a reasonable guess as to the masses of the stars. The period is observed, or can be estimated from the arc of the orbit over which observations have been made. This gives us the semimajor axis of the orbit in kilometers, but direct measures with the micrometer give the same quantity in seconds of arc. Hence, the simple solution of an isosceles triangle, with the semimajor axis as the base and the sun (or the earth) marking the angle measured with the micrometer, leads to the distance, in kilometers or parsecs.

In this manner Trumpler found, in 1921 from 10 binaries, a distance of 100 parsecs, the parallax being 0″.010, probable error 0″.006. A more recent discussion by L. Gratton, in 1938, gave 0″.009, probable error 0″.003. Even larger is Hertzsprung's 0″.016 determination, based on Aitken's binary No. 2755, which has had nearly a full revolution. Thus, we again have a considerable range of values, from 62 to 111 parsecs.

The famous *moving cluster* method which has given reliable results for the Hyades, and which is based upon a determination of the convergent point in the sky toward which the proper motions of the individual stars are directed, fails for the Pleiades. Their apparent motions are so nearly parallel that it is impossible to determine a convergent point with any degree of certainty. But a hypothetical value of the parallax can, nevertheless, be found if we combine the observed proper motions, in seconds of arc, and the radial velocities, in kilometers per second, and assume that the motion of the Pleiades as we see it represents only the reflex of the motion of the solar system. In other words, we suppose that the Pleiades are at rest with respect to the mean of the stars in the sun's neighborhood.



**Pleiades stars may be identified by their common proper motions. Non-members do not move parallel to the cluster stars. Illustration from "L'Astronomie," by Rudaux and de Vaucouleurs.**

The resulting parallax angle is 0.014 second of arc, with the probable error 0″.006, but the assumption may well be wrong. Also, we have as yet no very accurate determination of the radial velocity of the Pleiades cluster. The best is probably that found at Dominion Astrophysical Observatory by J. A. Pearce, but observations at McDonald Observatory gave a discordant result; this discrepancy has not been cleared up.

The average value for these geometrical methods is about 1/100 of a second of arc, or just about 100 parsecs.

*Photometric Methods*

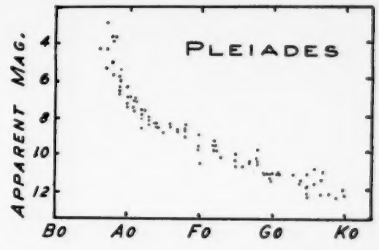
The photometric methods involve a procedure long known to astronomers, and already applied by several of them to the Pleiades. We determine as accurately as possible the photographic and photovisual or photored magnitudes of the cluster stars. The difference, photographic minus photovisual (or photographic minus photored), is the *color index* of each star. Then we prepare a graph in which the ordinate is the photographic magnitude of each star and the abscissa is its color index. Each Pleiades star appears as a single dot in the diagram, and the arrangement of all the dots closely resembles that of the main sequence of an H-R diagram (see *Sky and Telescope,* page 251, August, 1949), ranging from blue stars with negative color indices and naked-eye photographic magnitudes to red stars with color indices of the order of one magnitude (similar to that of the sun) and photographic magnitudes of the order of 13.

If we compare this modified H-R diagram with one constructed for nearby stars (for which accurate distances are known) in which the abscissae are the same, but the ordinates are *absolute* photographic magnitudes instead of *apparent* magnitudes, a superposition of the two main sequences gives us directly the difference of the two main magnitude scales. This *distance modulus* is usually written as $m - M$, where $m$ is the apparent magnitude of a cluster star and $M$ is the absolute magnitude of a similar star in the sun's neighborhood.

This distance modulus is directly related to the distance of the cluster stars. Indeed, $M$ refers to an *assumed* distance of 10 parsecs; $m$ refers to the true distance of the cluster; thus $m - M$ measures the reduction in the brightnesses of the cluster stars due to their distance in excess of 10 parsecs. If $m - M$ were one magnitude, we would conclude that the cluster stars were 2½ times fainter than they would have been at 10 parsecs. Light diminishes as the square of the distance. Hence, the cluster distance would be the square root of 2½, or 1.6 times greater than 10 parsecs, making 16 parsecs in all.

For the Pleiades, earlier applications of this method have given distance moduli of the order of 6.0 magnitudes (Trumpler) to 7.6 magnitudes (Gratton). The resulting parallaxes are 0″.006 and 0″.003, both much smaller than those from geometrical methods.

The fact that there is a major discrepancy between the geometrical methods and the method based upon the modified H-R diagram has been known for several years. Some astronomers have preferred to divide the difference, and have adopted a mean value of the parallax. Others, for example Gratton, have suggested that the main sequence of the Pleiades, especially in the region of the redder stars, lies abnormally low — lower, in fact, than the main sequence of the stars of the sun's immediate surroundings, and have thus in effect ignored the H-R diagram. Thus, Bin-

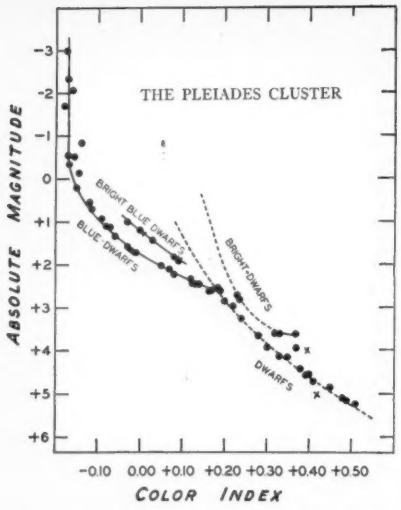



**An H-R diagram of the Pleiades, showing their scatter on the main sequence.**

nendijk's final value of the parallax is identical with that of Gratton by this method, 0″.010, which corresponds to 100 parsecs. If anything, the geometrical methods alone suggest an even smaller distance, perhaps 85 or 90 parsecs.

*Recent Studies*

During the past two years there appeared two independent studies of the Pleiades. The one better known in this country is by O. J. Eggen, and contains photoelectrically determined colors of 77 stars in the Pleiades brighter than photographic magnitude 11.0. Eggen made a special effort to secure the highest possible accuracy. He used only the very best nights available to him at the high elevation of Lick Observatory. His results indicate a *dwarf sequence* in the Pleiades, which he identifies with a similar sequence in the Hyades, for which the distance (and therefore the absolute magnitudes) is already known. The




**O. J. Eggen's photoelectric magnitudes and colors of the Pleiades. The dashed lines mark Hyades sequences (the giant branch not shown); the solid lines, those added by the Pleiades.**

comparison gives a distance modulus for the Pleiades of 5.75 magnitudes, which corresponds to 0″.0071, or 140 parsecs.

In addition, Eggen finds three other sequences, designated as *blue dwarfs* and *bright blue dwarfs* among the more luminous stars, and as *bright dwarfs* for a few objects which lie above the narrow dwarf or main-sequence band. Eggen has produced a large amount of evidence confirming the reality of these distinct groupings. For example, there is a pronounced difference in the rotational velocities of the bright blue dwarfs and the ordinary blue dwarfs. Moreover, the splitting into these two sequences is confirmed by the other study which we shall discuss in a moment. The bright dwarfs are also suspected in this latter study, but they stand out less conspicuously as an independent sequence. Altogether, there is good agreement in the observations.

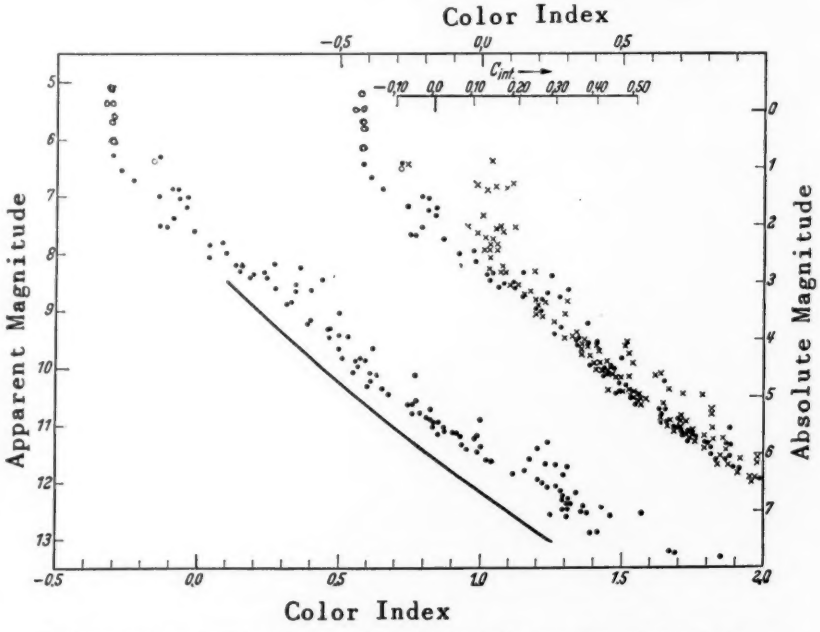
The question remains of whether or not the resulting distances are equally reliable. Eggen's procedure rests upon the assumption that the dwarf sequences of the Pleiades and Hyades are identical. This is an important matter, because previously we believed that the main sequence had an appreciable width, with some stars about one half a magnitude brighter and others the same amount fainter than the average line. There was then no evidence that in different clusters the dwarf stars all had exactly the same properties. In fact, it was believed that small differences in original chemical composition, or in age, might slightly alter the course of the main sequence.

The other important contribution to this problem comes from S. Guenther, of Goettingen. He first undertook a careful photographic determination of the magnitudes of the Pleiades at two effective wave lengths, in the blue and red parts of the spectrum. The catalogue thus obtained, though individually less accurate than the one by Eggen, seems to be free from systematic errors.

The modified H-R diagram based upon these observations is shown below. The solid-line curve represents the main sequence of the cluster Praesepe, determined earlier at Goettingen by O. Heckmann and H. Haffner. The two main sequences are parallel within the interval shown, that is, for stars fainter than magnitude 8.6. It was already known that for the brightest stars of each cluster there are large departures in their respective sequences; these differences probably point to differences in the ages of the clusters, and perhaps in their chemical compositions. But the lower parts of the main sequences were not previously known to be so very nearly parallel.

It should be noted that the main sequence of the Pleiades lies about 0.5 magnitude higher than the main sequence of Praesepe. If we next take the regular, unmodified H-R diagram, in which spectral types are the abscissae (instead of color indices), we find that the main sequence of the Pleiades lies only about 0.1 magnitude above the main sequence of Praesepe. But stars of the Pleiades are redder than those of the same spectral type in Praesepe, and this reddening is attributed to the absorption of interstellar (or nebular) particles. This reddening corresponds to a photographic dimming of the blue starlight of the Pleiades amounting to 0.4 magnitude on the average. Thus, the regular unmodified H-R diagram for the Pleiades must be corrected upwards by 0.4 magnitude for each spectral class, and we obtain the same separation of 0.5 magnitude for the modified and unmodified diagrams. Therefore, the Pleiades are closer to us than Praesepe, the difference in their distance moduli being 0.5 magnitude.

Guenther proceeds to evaluate the distance of the Pleiades, with the help of the distance of Praesepe, which in turn rests upon a supposedly very accurate value for the distance of the Hyades. The process is rather involved, and some astronomers will question first the two basic assumptions, clearly stated by Guenther, that the main sequences of Praesepe and the Pleiades are really identical, and that Praesepe is completely free of interstellar absorption. Second, they will question the precision of the adopted distance of Praesepe (parallax of 0″.0077, probable error 0″.0002), which Guenther takes from a 1940 paper by J. Ramberg, and which rests upon the latter's evaluation of the difference in the distance moduli of Praesepe and the Hyades. There has been some recent work on the main sequence of the Hyades, and R. E. Wilson's comments at the conclusion of a paper by Ramberg, at a symposium at the Zurich meeting of the International Astronomical Union, clearly show that the parallax of 0″.028 for the Hyades, which was used by Guenther, may require a revision. Eggen had access to this revision but Guenther did not. However, if we disregard these objections, the parallax of the Pleiades, as given by Guenther, turns out to be 0″.0096, almost exactly as was found by the geometrical procedures.




**S. Guenther's composite diagram, from "Zeitschrift fuer Astrophysik." At the right, Pleiades stars are closed and open circles; Praesepe stars are crosses.**

But even aside from the uncertainties involved in the intermediate steps of Guenther's procedure, there immediately appear certain difficulties which he himself has fully recognized. The main sequence of the Pleiades now departs noticeably from that of the solar neighborhood: the late *A* and the *F* stars of the Pleiades come out intrinsically fainter than the stars in our vicinity having similar spectra. It is difficult to find a satisfactory explanation for this strange behavior. We know definitely that the hottest stars in each cluster tend to depart from the conventional main sequence in the sense that they are too bright. This is convincingly shown in the right-hand part of Guenther's diagram, in which he has superposed the modified H-R diagrams of the Pleiades and Praesepe (after correction of the former for interstellar absorption and for the difference in distance of the two clusters). The Pleiades begin to depart at color index −0.4, making the main sequence shoot up at that point; in Praesepe this departure occurs at color index 0.0 (both on Guenther's scale; the international color indices would be −0.20 and +0.15).

The distance modulus found by Eggen was 5.75 magnitudes. Guenther gives 5.07 magnitudes. The corresponding distances are 140 and 104 parsecs. The difference of more than half a magnitude in the distance moduli is much too large to be accounted for by errors in the observations. Undoubtedly, Eggen's determination is to be preferred, first because it rests directly upon the distance of the Hyades, and second because he was able to use Wilson's new determination of the convergent point of the Hyades, and thus had at his disposal a more reliable distance for that cluster.

Both methods assume that the lower part of the main sequence, or what Eggen calls the dwarf sequence, is identically the same in all clusters, and in the sun's neighborhood. Eggen goes further, and suggests that all his groupings are intrinsically fixed and that clusters differ only in the numbers of stars which they possess in each sequence. If a star is present, it falls exactly (or within a very few tenths of a magnitude) upon that sequence. Occasionally, a sequence may be missing completely, while some other sequence may be heavily populated. If this conclusion is adopted, then the distance of 140 parsecs for the Pleiades must be very close to the truth.

But what about the discrepancy between the geometrical and photometric methods? Guenther's result would appear to erase it, whereas it still exists with Eggen's result. Perhaps future studies will decrease the numerical values of the geometrical parallaxes, as they are not intrinsically very accurate. This would confirm Eggen's views.

Somehow, however, we are left with the feeling that not everything has been cleared up. Perhaps there is more to this discrepancy than meets the eye. It is possible (though not at this time probable) that Eggen's parallel sequences (the dwarfs and bright dwarfs; the blue dwarfs and the bright blue dwarfs) are not distinct groupings, but represent a distribution of stars with a sharp cutoff on the side of fainter magnitudes and a more gradual decline on the other side. To distinguish between the two possibilities, it is important to invent better geometrical methods.

Trumpler long ago pointed the way when he demonstrated that the H-R diagrams of different clusters are not always the same. We are quite accustomed to the large differences in the H-R diagrams of the stars of Baade's two populations. Why should we necessarily expect that the lower parts of the main sequences of different clusters are identically the same, when we have every reason to believe that the upper parts differ, and that the clusters themselves differ in constitution, in density, in the abundance of diffuse, nebular material nearby, and in their locations within our stellar system? On the contrary, should we not recognize the difference between geometry and photometry as a promising clue toward the elucidation of the physical problems of stellar origin and evolution?

Before we leave this subject, we should note another recent attempt to determine the distance of the Pleiades. At Heidelberg, G. Miczaika made use of a method originally proposed by A. Unsöld and the present writer. The hydrogen absorption lines of the hotter stars are sensitive to pressure. In dwarf stars, of low luminosity and consequently small surface area, but large surface gravity, these lines are broad. Near the Balmer limit they flow together, forming a spurious continuum of absorption produced by the overlapping wings of several distinct lines. In giant stars, the lines are narrow and can be seen distinctly quite close to the series limit.

By counting the number of hydrogen absorption lines in each star, it is possible to derive an estimate of its intrinsic luminosity, and therefore of its distance. For the Pleiades average, Miczaika finds a parallax of 0".010, which agrees closely with the conclusions of Guenther and the geometrical methods. This result, however, is probably not very accurate, for the spectra of the hotter members of the Pleiades are abnormal, and so are their luminosities. But perhaps with respect to the criteria of this method their spectra are not peculiar.

How far are the Pleiades? Perhaps as near as 200 light-years, perhaps as far as 450. As we have seen, we cannot be more definite than this at the present time, but work already in progress at several observatories will probably soon bring us an answer.

## THE SEPTEMBER ANNULAR ECLIPSE

*(Continued from page 163)*

### *Green Flash*

This also requires an unusually clear sky in order that the short wave lengths of solar radiation be not completely absorbed or scattered. The aim is to ascertain if the green flash is more readily observable when only a thin crescent of the sun is exposed than it is under normal conditions.

It will be useful to look for the flash and to time the sunrise on August 31st at the station where one is to watch the eclipse the next day. This will allow full account of the effect of atmospheric refraction and dip of the horizon to be determined, and thus prevent the occurrence of lost minutes or wasted photographic film if one is to observe and record all of the drama on the big day.

### *Duration of Annular Phase*

The maximum time between second and third contacts in the continental United States will be two minutes 40 seconds. This is the same as the time required for the entire solar disk to rise at the latitude of observation.

It may therefore be possible for observers at the western end of the path to witness the beginning of the annular phase when the upper limbs of sun and moon are on the horizon and later to see the end of it when the lower limbs come in view. Midway between these times, the horizon will bisect both disks. The dip of the horizon is very critical here.

The magnitude of the eclipse will be 96 per cent. That is the maximum fraction of the solar diameter that will be obscured by the moon.

### *Distortion and Shadow Bands*

Where the sun completely emerges above the horizon just before the annular phase begins, note the distortion of the solar crescent by atmospheric refraction. Then at the middle of the eclipse, the ring of sunlight will be decidedly oval.

Should it be one of those hazy days when the rising sun appears through a red filter of air, such that it can be safely observed with the naked eye, the rapidly breaking crescent and slowly changing ring will provide a thrilling spectacle for all.

Some may wish to look for the shadow bands that are seen shortly before and after totality in a total solar eclipse. It will be necessary to erect a vertical white screen because of the very low altitude of the sun.

# Amateur Astronomers

## Convention Notes and Eclipse Map Information

RESERVATIONS for accommodations in University of North Carolina student dormitories at Chapel Hill, for the annular eclipse convention of the Astronomical League, September 1-3, Saturday to Monday, may now be made. A deposit of $5.00 per person is required, payable to Elizabeth Fazekas, convention treasurer, to be sent to her at 3309 Scott St., Portsmouth, Va. A late reservations charge of 50 cents per person will be added each month after July 1st. The balance due will be payable upon arrival at the convention. Refunds for cancellations will be made after the convention.

The dormitory rate is $2.75 per night for one person; $4.00 per night for two in a room; and rooms will be available Friday, Saturday, and Sunday nights. Meals are not included, but there are several restaurants nearby. Anyone who intends to stay at the Carolina Inn in Chapel Hill should make reservations directly with that hotel.

The regular convention registration fee is $1.00.

*Weather Information*

A group will observe the eclipse from near Chapel Hill. If you prefer to choose your own site nearer the central line, ask Miss Fazekas for these lists when you send your reservation:

1. Radio stations in the eclipse region that carry weather information, and times of day that weather forecasts are given. Since the eclipse is at sunrise, most of this information will be broadcast late Friday night.

2. Data on the type of early morning weather in various parts of the eclipse area, now being compiled from records of the Weather Bureau.

3. A list of weather reporting stations in the region. This will give the name of the city and the radio frequency on which they broadcast hourly weather information. These broadcasts are on long wave and require a special radio receiver. However, the telephone number of each station will be included, and as the stations are operated day and night it will be possible to call at any time and make a last-minute change of observing location because of cloudy weather. Each station will be able to give current data of the others because they have teletype communication.

*Selection of Observing Sites*

The U. S. Naval Observatory has agreed to furnish a limited number of its Circular No. 27 regarding the eclipse, which will be sent to early registrants as long as the supply lasts. A map of the eclipse path in the United States is part of this circular. The general position of the path is shown on the map with the eclipse article on page 162 of this issue of *Sky and Telescope*.

To pick your own observing site, you will need road maps and topographic maps. The road maps, of course, will show the routes, and the more detailed ones of a single state are best. Most gasoline companies maintain map services, and will procure for you the maps you need, but it is wise to compare several different road maps as not all of them contain the same features.

Topographic maps show the elevations of all the high spots and give contours of surrounding land. For the eclipse region, if you want a full set of aviation maps, order Nos. WAC 409, WAC 410, WAC 357, and WAC 358 from the Director, Coast and Geodetic Survey, Washington 25, D. C. Be sure to specify maps without the red overprint, for a red overlay is printed with air navigational information on some maps. The ones without the overprint should be more useful. (However, if you live near an airport, you may be able to obtain or examine one with the navigational overlay.) These maps cost 25 cents each, and your remittance should be made payable to the Treasurer of the United States. Do not send stamps. Trim and mount the maps; then plot the course of the center line of the eclipse, and select likely sites for your observing point.

It seems that the detailed topographic maps of the Geological Survey of some areas in North Carolina in which we are interested have never been published, and the same is true of one section in Virginia. These maps cover only small areas, and therefore several are necessary in order to have an area of sufficient size to study. Indexes to the maps of Virginia and North Carolina may be obtained free from the Geological Survey, Department of Interior, Washington 25, D. C.

When these indexes are in hand, you may check the areas of the likely observing sites you have chosen to see whether or not the detailed topographic maps are available for those particular spots. If so, they may be ordered for 20 cents each according to the instructions in the indexes.

G. R. Wright, chairman
Astronomical League convention
202 Piping Rock Dr.
Silver Spring, Md.

### THIS MONTH'S MEETINGS

**Buffalo, N. Y.:** At the May 2nd meeting of the Amateur Telescope Makers and Observers of Buffalo, a 35-minute color film on "The Giant Ungava Meteor Crater of Labrador" will be shown, after which Dr. F. Shirley Jones will speak on "The Cosmic Yardstick." The final meeting of the season will be held on May 16th; both meetings are at 7:30 p.m. at the Buffalo Museum of Science.

**Cambridge, Mass.:** The Bond Astronomical Club, on May 3rd, 8:15 p.m. at Harvard Observatory, will hold its annual meeting. Short talks by members on subjects of their choice will be featured.

**Cleveland, Ohio:** The Cleveland Astronomical Society will hold its annual dinner meeting on May 25th, when Dr. J. J. Nassau, of the Warner and Swasey Observatory, will speak on "Our Place in the Universe."

**Columbus, Ohio:** On May 11th, Friday, Leon Schroeder will discuss "Astronomical Instruments," before the Columbus Astronomical Society, 8:00 p.m. at McMillin Observatory.

**Dallas, Tex.:** The Texas Astronomical Society, on May 28th at 8 o'clock in the Dallas Power and Light Co. auditorium, will hear Jack Kucera speak on "Types of Stars."

**Detroit, Mich.:** On Sunday, May 13th, at 3:00 p.m. in State Hall of Wayne University, the Detroit Astronomical Society will have a program of astronomical motion pictures, with William Schultz, Jr., of Cranbrook School, as narrator.

**Indianapolis, Ind.:** "New Questions of Astronomy" will be discussed by Russell Sullivan at the May 6th meeting of the Indiana Astronomical Society, 2:30 p.m. at Riley Library.

**Madison, Wis.:** Following a discussion of summer constellations, Dr. J. S. Supernaw will speak on "Eclipses," at the meeting of the Madison Astronomical Society on May 9th, 8:00 p.m. at Washburn Observatory.

**Minneapolis, Minn.:** Dr. L. Binnendijk, of Goodsell Observatory, will speak at the May 2nd meeting of the Minneapolis Astronomy Club on "The Pleiades and the Area." On May 23rd, the Rev. Francis Nolan will show pictures from his European trip. Both meetings are at 7:30 p.m. in the Library Science Museum.

**New York, N. Y.:** The annual meeting of the Amateur Astronomers Association will be held on May 16th at the American Museum of Natural History, 8:00 p.m.

**Rutherford, N. J.:** The Astronomical Society of Rutherford will hear a discussion on the moon at its May 3rd meeting, to be followed by outdoor observation, at the Y.M.C.A. at 8 o'clock.

**Washington, D.C.:** "Optical Instrumentation for Guided Missiles" will be the subject of the lecture by Dr. Dirk Reuyl, of Aberdeen Proving Ground, at the May 5th meeting of the National Capital Astronomers, in the Commerce Building auditorium at 8 o'clock.

### LEAGUE EMBLEM CONTEST

All entries in the Astronomical League emblem contest will be displayed at the 1951 convention in Chapel Hill, and the contest is therefore closing at midnight on July 1st. Individuals may enter em-

blem designs, or league member organizations may sponsor local competitions and submit their best local efforts in the national contest, the purpose of which is to obtain for the Astronomical League a suitable insignia for stationery, programs, publications, and for possible use as a lapel pin or button.

Emblem contest rules have been sent to all member organizations, which should make them available in turn to individuals. The rules will be printed in the May issue of the Astronomical League **Bulletin.**

Emblem designs are to be in two colors, of any shape but planned to look well when reduced to 3/4 inch in size. Simplicity should be the keynote, and all lettering (or type matter) should be solid. The design should be national or international in character. The council of the Astronomical League will select a suitable prize for the winner of the emblem contest.

D. F. MATHE, chairman
Astronomical League Contest
309 Triangle Bldg.
Pittsburgh 22, Pa.

### NORTH CENTRAL CONVENTION MAY 11-12

The North Central region of the Astronomical League will convene in Chicago on the weekend of May 11-12, with the Burnham Astronomical Society as host. Friday evening there will be open house at the Dearborn Observatory, Northwestern University, Evanston, and Saturday sessions will be at the Adler Planetarium, beginning at 10:00 a.m. Papers by members of North Central societies are scheduled, as well as society reports and a business session. A demonstration of the Adler Planetarium is on the program, as well as a banquet for Saturday evening. Further information may be obtained from the Burnham Astronomical Society or from R. N. Buckstaff, Oshkosh, Wis.

The program includes talks on asteroids, stellar photography, variable stars, sunspot activity, U Cephei, a book review, and a description of astronomical work done by members of the host society.

### AAVSO SPRING MEETING

The 40th spring meeting of the American Association of Variable Star Observers will be held May 11-13 in Washington, D.C., on invitation of the Rev. Francis J. Heyden, S.J., Georgetown College Observatory, and of the National Capital Astronomers. Registration will be on Friday, May 11th, from 2 to 5:30 o'clock in Copley Lounge at Georgetown College, with a lecture at 8 o'clock in the same place by Dr. John S. Hall, U. S. Naval Observatory, on "Effects of Scintillation of Stars." A visit to Georgetown Observatory will follow.

Saturday morning and afternoon are devoted to business and sessions for papers, with luncheon and a buffet supper on the observatory lawn. There will be a visit to the Naval Observatory Saturday evening. Special field trips are planned for Sunday, to Sterling field station of the National Bureau of Standards in the morning, and to the radio astronomy section of the Naval Research Laboratory, where there is a new 50-foot parabolic radio telescope, in the afternoon.

# WATCHER OF SOUTHERN SKIES

SINCE 1923, Dr. John S. Paraskevopoulos had been superintendent of the Harvard Observatory's southern station. His life, which terminated after a short illness on March 15th, was one of singular devotion to the large station he directed. His personal concern for the star plant on the African veld was natural — he had built it. It was his child, his worry, and his pride; and now it is his monument.

Dr. Paraskevopoulos, member of a distinguished Grecian family, was born in the Piraeus, educated in Athens, and fought through many long years of Balkan and world wars. Coming to America after World War I, he carried on studies at Yerkes and Mount Wilson observatories and at the United States Weather Bureau. After his marriage to Dorothy Block, of Brooklyn, who was a young colleague at Yerkes, he returned to the National Observatory in Athens.

In 1922, when making a brief tourist stop in Greece, I walked over from the Acropolis to the observatory on an adjacent hill. There I found Dr. and Mrs. Paras sitting on the floor, sorting star charts. It was not hard to discover a nostalgia for American institutions, and a few months later he received a cablegram extending him an offer to become successor to Solon I. Bailey, in charge of Harvard's Boyden station in Peru. Dr. Paras already knew four languages, but he cheerfully took on another. Spanish he was willing to add to the list, but some years later he flatly balked at learning Afrikaans and Basuto. "The expletives will be enough!"

The Boyden station in Peru, operated with a small staff and small equipment, was in a fairly good location, but our interest in and responsibility for the Magellanic Clouds made us impatient with the December to March clouds of Arequipa. First, Dr. Paras tried out two other South American sites. The one on the two-mile-high Atacama Desert was superb in many ways (perhaps the best astronomical site in the world?), but the windiness, and especially the rigors and isolation of the north Chilean locale led us to move the station to South Africa, where slightly better "Magellanic weather" was found.

The transfer and building up of this station in the Orange Free State, with its new instruments and new mountings, was Dr. Paras' largest contribution. The choosing of a site in 1927 was a task involving meteorology, politics, roads, water supplies, and human relations. In such matters Dr. Paras moved with a skillful step. The eagerness of the Bloemfontein Council, for example, was not noticeable until Dr. Paras, in response to a hard-sounding cablegram went over to Kimberley. There he was received with great ceremony. He praised highly to the Kimberley press the kopjes of that region. Immediately the Bloemfontein Council bought the hill that we desired and transferred it to the Harvard Corporation for one shilling (which I believe has not yet been paid).

With his assistants and telescopes, Dr. Paras has added more than 100,000 plates to the Harvard collection. He has provided the observational material for a score of researches on the positions, light variations, colors, and spectra of numberless stars, and on the distribution of half a million galaxies.

**The ADH telescope arrived by ship at East London, South Africa, in October, 1950, where it was met by Dr. Paraskevopoulos. Back at the Bloemfontein station, he and Dr. Bok (right) inspected the shipment together. Photo by "The Friend," Bloemfontein.**

During the last year, under Dr. Paras' guidance, the Boyden station has added an important new instrument — the ADH Baker-Schmidt telescope. Under his direct supervision, the installation was completed and the instrument put into operation in less than two months time.

He could always count on the respect and devotion of his staff, and the sympathetic support of the South African community. In this past year he had the good fortune of having Dr. Bart J. Bok with him, and also two graduate students from Harvard, Ivan R. King and Uco van Wijk. The transition to a new regime will be made relatively simple because of the neat efficiency of his organization.

HARLOW SHAPLEY
Harvard College Observatory

# The Problem of the Red G

By Lloyd Motz, *Rutherfurd Observatory, Columbia*

ONE OF THE MOST perplexing problems facing the astrophysicist today is the internal constitution of the red giant stars. As a group, these stars have diameters ranging anywhere from 10 to a few hundred times the sun's diameter (which means their volumes equal thousands to millions of solar volumes). Their masses have a much more limited range, varying from four to perhaps 25 solar masses. These two characteristics tell us that the red giants have very low average densities, of the order of a few thousandths to a few 10 millionths the density of water.

If the mass and the radius were the only characteristics to be accounted for, one could very easily, on the basis of the standard laws of physics, design a stellar model similar to that of the sun to describe these stars correctly. However, red giants are in general thousands of times more luminous than the sun. It is precisely this feature which makes it impossible to construct a red giant star on a solar model, if one assumes that the giant star obtains its energy from nuclear processes similar to the carbon cycle and the proton-proton reaction, which are believed to operate in the deep interiors of stars like the sun. [See "The Source of Energy in the Fainter Stars," by Lawrence H. Aller, in *Sky and Telescope* last month.]

In 1939, G. Gamow and E. Teller assumed that the red giants use the light elements deuterium, lithium, and so forth, instead of hydrogen as their basic fuel. But this would mean that giants would have short lives, and this is contradicted by the abundance of these stars. Since at the present time no other nuclear sources of energy which can operate at the necessary efficiency under the given stellar conditions are known, it becomes necessary to apply a new stellar model to the giant stars.

It is perhaps easiest to understand what the essential difficulties are in developing a correct theory of the internal constitution of these giant stars if we consider briefly the nature of the problem and its solution for the main-sequence stars, such as the sun.

There are two general principles one can use as a guide in studying the internal structure of stars. The first of these says: A state of mechanical equilibrium must exist at each point within the star. This means that the star is neither exploding nor collapsing. The second principle tells us: A steady state prevails at each point. This means that in spite of the continuous radiation of energy from the stellar surface (with its concomitant replenishment from some internal source), the prevailing conditions at any point within the star are changing so slowly that they may be considered as being constant over very long periods of time.

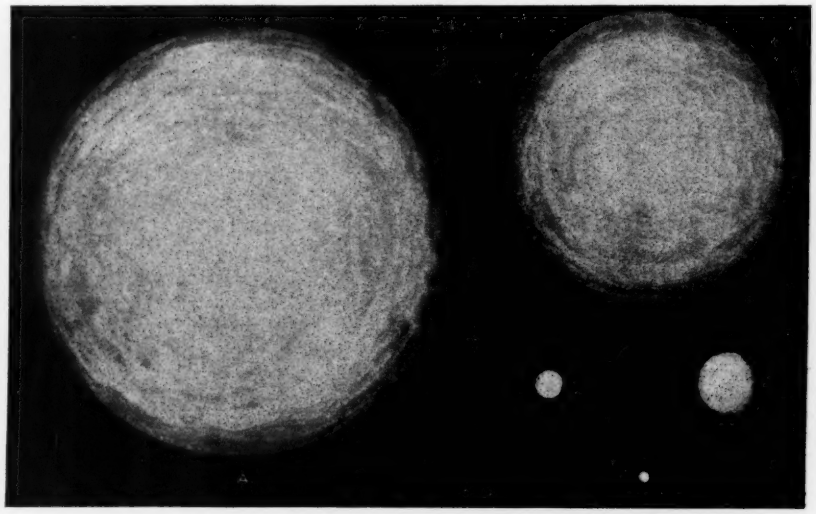
If we use these two conditions, we can design a model of the sun, or stars like it. That is, we can specify a run of temperature, density, and pressure values from the center to the surface, and also values for the hydrogen and helium contents, all such that the correct total luminosity is obtained for a star of given mass and radius.

The procedure for doing this is somewhat as follows: At each point within the sun we first impose the condition of equilibrium, so that the inward gravitational pull on an element of matter at the point is balanced by the outward pressure of the underlying gases. This is done in the form of an equation relating the rate at which the gas pressure increases as we penetrate inward to the manner in which the weight of an element of matter (the acceleration of gravity) changes as we move toward the center of the sun. A second relationship is obtained by requiring that if the sun were to be divided into a series of concentric spheres, each differing only slightly in volume from its neighbor above and below, the mass contained within each sphere would differ only slightly and in a predictable manner from the masses of the two neighboring spheres. These two relationships are not sufficient to solve the problem completely, since there is a continual outflow of energy from the interior to the surface of the star. Therefore, a third relationship must exist defining the conditions at each point that maintain this stream of energy at a constant rate.

It was shown by Eddington that at least for the major part of its outward journey the energy moves along as a stream of radiation. Let us focus our attention on some point within the sun and follow a stream of radiant energy as it moves from this point to some nearby point farther out from the center. For this radiation to overcome the resistance it meets in the form of absorbing atoms (the opacity of the material), it must be pushed out by some force from below. This force is determined essentially by the temperature gradient at the point. The third relationship, therefore, is an equation which states that the temperature gradient at points within the sun where there is a radiative flow of energy must be proportional to the outward flux of energy and to the opacity of the solar material.

These three relationships are supplemented by two other conditions. One is an assumption about the state of the matter inside the sun, and the other equates the net outward flux of energy through the surface of any interior sphere drawn about the center of the sun to the total amount of energy generated in that sphere. We have assumed that the solar material exists in the gaseous state. This is permissible, since the interior temperatures are so high that all the atoms are very nearly completely ionized (almost completely stripped of their ring electrons). Under these conditions, one may assume that the gas pressure at any point within the sun is related, by the formula for a perfect gas, to the temperature, the density, and the mean molecular weight of the gases at that point.

It will be noted from the discussion above that five conditions (mathematical equations) have been introduced to describe the behavior at each point within the sun of the following five quantities:



**Relative dimensions of some giant stars of various spectral classes: A, Epsilon Aurigae, K5; B, Beta Pegasi, M5; C, Capella, G0; D, Arcturus, K0; E, Y Cygni, O9. Drawing from "L'Astronomie," by Rudaux and de Vaucouleurs.**

# ed Giant Stars

*Columbia University*

the gas pressure, the density, the temperature, the radiant flux, and the acceleration of gravity. Mathematicians have shown that if a number of quantities are related among themselves by the same number of conditions, it is possible to evaluate the quantities at each point where the conditions are valid. But it will be recalled that three other quantities have also been mentioned above; the opacity of the stellar material, the mean molecular weight of the stellar material, and the rate of energy generation. Fortunately, we can make use of discoveries made by physicists to show that these quantities are related in a very definite and known way to the five quantities we are seeking.

Thus, it can be shown that because of the high temperatures and consequent ionization, the mean molecular weight within the sun depends entirely upon its hydrogen and helium contents. Similarly, the opacity of the stellar material can be expressed in terms of the temperature, density, and the hydrogen and helium contents at each point. There remains to be considered the rate of energy generation at various points in the solar interior.

The first solution to this problem was obtained in 1938, by H. A. Bethe, and independently by C. F. von Weizsaecker. They showed that the release of energy in the interiors of stars like the sun could be explained by the transformation of four protons into a helium nucleus by means of a thermonuclear reaction. These scientists investigated two nuclear processes in detail: 1. The proton-proton reaction, in which two protons combine to form a deuteron, from which helium is ultimately formed by the capture of two more protons. 2. The carbon cycle, in which the carbon nucleus acts as a sort of catalyst in the transformation of four protons into helium.

When this work was first done, the known nuclear collisional cross-sections and reaction probabilities pointed to the conclusion that the proton-proton reaction would be of relatively little importance for the overall energy-generating problem in the main-sequence stars. For this reason, the carbon cycle was used almost exclusively in the investigations of the internal structure of the sun. During the last year, however, improved nuclear cross-sections for processes in the carbon cycle and the calculations of I. Epstein have shown that the proton-proton reaction is anywhere from six to 12 times more important than the carbon cycle in the sun. However, since no complete calculation using both the proton-proton reaction and the carbon cycle has been carried out, we shall discuss this problem only in terms of the carbon cycle. We shall later point out what variations may be expected because of the great contribution from the proton-proton reaction.

From a knowledge of the properties of nuclear reactions, Bethe was able to show just how the carbon cycle would depend on the temperature, density, and hydrogen content at points within the sun, and these factors could thus take the place of the rate of energy generation in one of our five principal relations.

Since the relations involve not only the five quantities previously mentioned but also the hydrogen and helium concentrations, we must have some independent manner of determining these. In 1946, Martin Schwarzschild described the procedure for doing this. From Bethe's calculations for the rate of energy generation, it can be shown that this rate depends very sensitively on the temperature; in fact, it varies with the 20th power of the temperature. (Schwarzschild used the 17th power, as given by the earlier, since-corrected cross-sections.) This means that the carbon cycle must be limited to a very small core in the neighborhood of the center of the sun, where the temperature is highest. We may assume that outside of the core, in the region called the envelope, no energy at all is generated in this manner.

The energy generated in the core does not get out to the surrounding envelope by a radiative process, as we have postulated above for most of the star, but rather by means of convection (mixing) in the core. The reason for this is that the temperature increases so rapidly inward within the core that nonconvective equilibrium is impossible.

Schwarzschild has shown how the existence of a convective core, in which the entire energy of the sun is generated, makes it possible to determine the hydrogen-helium content and thus to establish the model for the sun completely.

## The Horsehead Nebula

*Now, ebon-dark on the outermost rim*
*Of a nebula fashioned of silver and sable*
*Rises the proudly arched head of the stallion*
*Orion keeps prisoner there in his stable.*

*Framed in a halo of shimmering star dust,*
*Hidden in part by a dark cosmic cloud,*
*Longing to gallop forth, free on the ether drift,*
*Ever transfixed he waits, lonely and proud.*

RORY FAULKNER

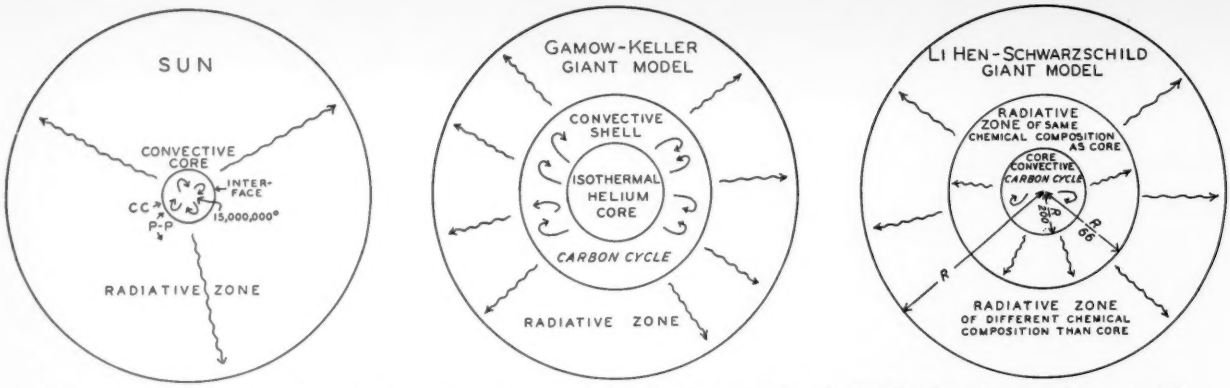
Since the core is in convective equilibrium, a set of relations must be used for the core different from those described above for the envelope. The physical characteristics at the core-envelope interface obtained with the core equations must be identical with those obtained from the envelope equations, but this can be so only if the hydrogen and helium contents are properly related to each other. This relationship expresses the well-known mass-luminosity law as applied to the sun.

The total luminosity of the sun is provided by the energy generated entirely within the convective core. Schwarzschild expressed this equality in an energy-production law involving a relationship between the helium content and the hydrogen content. This and the mass-luminosity law, together with the previously described five relations, enabled Schwarzschild to solve the problem of the sun and stars like it, assuming the carbon cycle only.

The results obtained for the sun readily show where the difficulty for the red giant stars lies. To supply the sun with energy, Schwarzschild found that the carbon cycle requires a temperature at its center of about 20 million degrees, a central density of about 150 grams per cubic centimeter, a hydrogen content of about 67 per cent, and a helium content of about 30 per cent (the remaining elements totaling only three per cent of the sun's mass). The high luminosities of the red giant stars require central temperatures of the order of 30 million degrees or more if the carbon cycle is to be the main source of their radiant energy. Furthermore, the central densities and pressures must be of the same order of magnitude as those of the main-sequence stars.

It can be shown, however, from simple equilibrium considerations, that if the red giants were built on the solar model, their central temperatures would be as much smaller than the sun's as their radii are larger than the sun's radius (the central temperatures are proportional to the mass divided by the radius), and the central densities of these stars would be even smaller. Actually, giant stars built like the sun would have central temperatures of the order of one or two million degrees, and their central densities would be of the order of one gram per cubic centimeter. Under these conditions, the carbon cycle could not operate.

Schwarzschild's solution of the solar problem, which we described here, is based on the use of the carbon cycle and the neglect of the proton-proton reaction. As we have already indicated, this is no longer justified, because the recent cross-section determinations for the carbon cycle show, according to Epstein, that this cycle depends upon the 20th power of the temperature rather than the 17th power. The pro-




**Models of the sun and giant stars. In the sun, the convective core has a radius about 1/10 that of the entire star. The carbon cycle (C C) in this model presumably occurs only in the core, while the proton-proton reaction (P-P) occurs both in the core and in the radiative envelope.**

ton-proton reaction, however, depends on the fourth power of the temperature, so that one may not neglect this reaction as compared with the carbon cycle except possibly right at the very center of the sun.

A correct solution of the solar problem must take both nuclear processes into account, and this is now being done at Columbia University by Epstein. Preliminary results of this work show that the essential features of the internal structure of the sun as described above are still retained, with an upward revision for the hydrogen content (about 82 instead of 67 per cent) and a downward revision for the central temperature (about 15 million instead of 20 million degrees). For giant stars one can expect the carbon cycle to be the important process if a model can be devised to give high central temperatures.

The giant stars have masses not much larger than the mass of the sun extended over volumes millions of times greater than that of the sun. Under such conditions, it is difficult to maintain a correct temperature gradient in order to establish a large enough convective core to generate the required energy. The problem, then, is somehow to establish a sufficiently high temperature at the centers of the giant stars to make the carbon cycle (or some other process) work, and then to devise some mechanism that can keep this high temperature from rapidly dropping down.

A number of suggestions have been made to insure this condition, and they are all based on the existence of three zones within a red giant star. The first suggestion was made by Gamow and G. Keller, in 1945, when they pointed out that as the carbon cycle progresses the hydrogen at the center of the star becomes depleted, changing to helium, until only helium is left at the center. Then the carbon cycle goes on, not throughout the entire core, but only in a shell of the original convective core in which there is still some hydrogen. Since only helium is left at the center, there can be no energy generated there according to this model, and the temperature throughout this helium core must be constant. Gamow and Keller thus suggested that giant stars have three zones: an isothermal (constant-temperature) helium core, where no energy is generated; a convective shell, in which the carbon cycle operates and all the energy is generated; and a radiative envelope consisting of most of the star.

This model has been shown to be capable of giving the necessary high shell temperatures for the intermediate giant stars (with radii of the order of 10 to 70 times the sun's radius), but R. S. Richardson and Schwarzschild have shown that this would no longer be true for the large red giant stars. They suggested, in turn, a model for giant stars consisting of a convective core, an isothermal zone, and a radiative envelope. The idea was that, after leaving the convective core, the energy would be transported across an isothermal zone in the form of sound energy or noise. Such a model can account for the red giants, but it meets with the fatal difficulty that the second law of thermodynamics prohibits the realization of such noise-zone models in nature.

More recently, Li Hen and Schwarzschild have devised another model for the red giants which gives promise of some success. They point out that since hydrogen is disappearing close to the center of the star, whereas this is not the case in the envelope, the chemical composition and therefore the mean molecular weight cannot be treated as constant throughout the giant star. Their model is thus based on a convective core, in which all the energy is generated, a radiative zone having the same chemical composition as the core, and a radiative envelope differing in composition from the core.

For this model, it is possible to obtain the necessary high central temperatures for intermediate giants. However, this does not solve the problem of the large red giants. This particular model may, nevertheless, be the correct approach to the solution, since it offers new avenues of investigation. Thus, the discontinuity in the chemical composition may be applied in various ways to give additional results.

As things stand today, we must conclude that no satisfactory model of the large red giant stars exists, although we have some approximate ideas of the overall picture. It is fairly obvious that whatever else is true about such a model, it cannot be of the simple two-zone type that applies to the sun. Indeed, it seems that even three zones will not suffice, and that ultimately more complicated structures will have to be investigated.

## *ASTRONOMER POSITIONS*

The U. S. Civil Service Commission has announced astronomer examinations for filling positions in the Navy Department (mostly at the U. S. Naval Observatory) and other agencies in Washington, D. C., and vicinity. Minimum requirements are four years of appropriate college study, or four years technical astronomical experience, or a combination. Professional experience or graduate study are required for the higher ratings. Entrance salaries range from $3,100 to $8,800 a year.

Further information may be obtained from most first- or second-class post offices, Civil Service regional offices, or from the U. S. Civil Service Commission, Washington 25, D. C.

## *METEORITICAL SOCIETY AND PACIFIC AAAS MEET JOINTLY*

The 14th meeting of the Meteoritical Society will be held with the Pacific division of the American Association for the Advancement of Science, June 18-20, 1951, at the University of Southern California, Los Angeles. The society shares invitations with the Astronomical Society of the Pacific to the Griffith Observatory on Monday evening, June 18th, and to the Mount Wilson Observatory on Wednesday afternoon, June 20th.

# BOOKS AND THE SKY

### METEORITIC DUST

**John Davis Buddhue.** University of New Mexico Press, Albuquerque, 1950. 102 pages and 8 plates. $1.50.

FOR MORE THAN a century there have been intermittent speculations, experiments, and explorations concerning the existence of dust particles of meteoric origin. The references to such investigations have been very sparsely distributed throughout all sorts of scientific journals, many of them not readily accessible to the average astronomer. **Meteoritic Dust** is therefore a very welcome contribution, summarizing the investigations of the past as well as giving ample details of the author's own recent and painstaking research. The treatise is No. 2 of the University of New Mexico publications in meteoritics.

The few pages of abstract with which the booklet begins are clear and concise. But in the matter of literary style the first pages of the text proper are a bit disappointing. They are little apt to appeal to the layman unless meteoritics already happens to be one of his potential hobbies. On the other hand, the contents of later sections do contain information that might well entice new amateur meteoriticists into this field, in which there is much room for co-operation from the enthusiastic amateur.

Buddhue's own experiments in collecting meteoritic dust were carried out mainly in the Arroyo Seco Canyon near Pasadena, Calif., but in a region protected and isolated from industrial areas. Nevertheless, he needed to exert much precaution in separating possible meteoric from strictly terrestrial material. His methods for collecting are described in sufficient detail to enable others to become collectors. Then follows his classification of the dust particles. There are many varieties, especially of the smooth spherical particles, some metallic, some silicate, many hollow because of the probable air bubbles trapped in them when presumably molten matter was swept off the surfaces of falling meteorites. Black metallic spheres are more numerous the smaller they are, whereas the silicates most frequently have diameters of about 0.02 millimeter.

After describing various physical and chemical tests of meteoritic dust, the author discusses the problem of the annual terrestrial accumulation of this material, its occurrence in snow and hail, the bearing of this work on studies of interstellar matter, the origin of the meteoritic dust, and the rate of fall of the particles within the atmosphere.

In the chapter on interstellar absorption, reference is made to hyperbolic meteors from which space densities had been determined in 1937. But, surprisingly, no mention is found of the sometimes heated debates that have subsequently arisen as to the reality of the observed hyperbolic velocities.

Theoretical velocities of fall, computed for dust particles of various sizes and for different altitudes, lead to estimates that over three days are required for a glass sphere of 0.02-millimeter diameter to reach the surface of the earth from a height of 100 kilometers. Turbulence in the atmosphere might greatly increase this time estimate. In observational confirmation of this, for the Draconid meteors dust had been obtained in Washington, D. C., by Landsberg, as early as two or three days after the meteor shower, whereas at Mt. Weather, Va., there was a full week's delay after the visible shower before the dust appeared.

The suggestion is offered that the magnetic field of the earth might exert a sorting influence on the distribution of magnetic meteoritic dust particles. Relative to the numbers of silicate particles found, the numbers of magnetic particles recovered might be greater near the earth's magnetic poles than near the equator. Perhaps cosmic ray stations can be induced to assist in collecting sufficiently widely distributed samples of meteoritic dust to test this suggestion.

Only very few grammatical or typographical slips are found. Here and there clarity could have been increased by the insertion of a few simple definitions. For example, on page 12 it is stated that Sterlitamak, where hailstones containing a compound of iron and sulphur fell in 1825, is 200 versts from Orenburg. Are we all familiar with this term for a Russian "mile," which is about 3,500 feet? There are a few misprints: In the list of references, Volume 85 of the **Astrophysical Journal** was published in 1937 (not 1947),

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**401 N. Broad St., Phila. 8, Pa.**



*Published April 18*

**The ORIGIN OF THE EARTH**

*by*

**W. M. SMART**

*Professor of Astronomy*
*University of Glasgow*

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and one volume for 1938 should be 87 (not 47).

All the various aspects of the studies of meteoritic dust should eventually lead to a better understanding of the material composition and structure of the non-stellar components of the universe. There are probably particles that never were parts of larger meteoroids, some that are derived from cometary meteor showers, and others that are in the nature of debris from a former planetary mass. John Davis Buddhue is to be congratulated on this resume of both historical and up-to-date knowledge of the subject at this particular time. The book is a valuable reference handbook for all meteoriticists: professional, amateur, and potential.

DORRIT HOFFLEIT
Harvard College Observatory

## THE STRUCTURE OF THE UNIVERSE

**G. J. Whitrow.** Hutchinson's University Library, Hutchinson House, London, W. 1, England, 1950. 171 pages. 7s 6d.

COSMOLOGY in its ultimate essence strives to reduce the apparent chaos that is called the universe into a semblance of order. Ironically, today's authors of texts on modern cosmologies find themselves striving to reduce the apparent chaos that is called cosmological theory into a semblance of order. A recent attempt in that direction is Dr. Whitrow's book. Even a cursory reading of it is sufficient to show that the leading cosmological ideas now prevalent contradict each other, not only in the conclusions derived from, but also in the interpretation given to observational facts. The red-shift phenomenon is the most obvious example of this.

One might say that the situation is such that all is being held in abeyance, waiting for the 200-inch telescope to make the next move. Nevertheless, the greatest advances in cosmological thought have been accomplished in the last 35 years. The value of **The Structure of the Universe** lies particularly in that portion of it which presents such work in its historical perspective. There have been a number of great writings on the subject, but the papers of the important men in this field, Eddington, Einstein, Hubble, de Sitter, Milne, and others, have necessarily been lacking in that eclectic viewpoint so essential to one who seeks an introduction into this fascinating aspect of astronomy. Although there is a considerable amount of mathematical treatment of the various subjects covered — relativity, world models, space-time, motion, the age of the universe, and the structure of the galaxies — this book is not without a distinct literary flavor. It is replete with quotations from the great cosmologists of the past, Kant, Herschel, Newton, Archimedes.

For those who want to organize their own thoughts a little better on the subject of up-to-date conflicts concerning the various world models, Dr. Whitrow's analysis should be helpful. Those not interested in the technical side of cosmology will find a clear, comprehensive treatment of the leading philosophical ideas about the universe — the universe which de Sitter has so aptly called "a hypothesis."

P. V. RIZZO
Brooklyn, N. Y.

## NEW BOOKS RECEIVED

THE NATURE OF THE UNIVERSE, *Fred Hoyle*, 1950, *Harper*. 142 pages. $2.50.

The author discusses in popular language known facts about the solar system and the universe, and analyzes various cosmological theories currently under consideration, including his own approach to the problem. This is an American edition of a book which appeared in England last year, based on the author's BBC radio talks.

THE ORIGIN OF THE EARTH, *W. M. Smart*, 1951, *Cambridge University Press*. 239 pages. $2.75.

Written for those who are not astronomers, this book discusses the latest knowledge about the cosmic and atomic aspects of creation, and evaluates theories of the origin of the solar system from Laplace to the present investigators.

MEN OF OTHER PLANETS, *Kenneth Heuer*, 1951, *Pellegrini & Cudahy*. 160 pages. $3.00.

The facts of solar system astronomy are presented by one of the lecturers at the Hayden Planetarium, together with his own speculations, in the realm of science fiction, on what life might be like elsewhere than on the earth.

WORKBOOK FOR WEATHER FORECASTING, *Pulk and Murphy*, 1950, *Prentice-Hall*. 66 pages and a map series kit. $5.00.

This laboratory manual, by Massachusetts Institute of Technology meteorologists, contains practical exercises on actual weather maps, both surface and upper-air, by means of which the student can apply and supplement his theoretical knowledge. Brief chapters on weather analysis and forecasting are included.


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# GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

## How to Build a Quartz Monochromator — II

By Richard B. Dunn, *Harvard Observatory*

THERE are only three kinds of uniaxial crystals that have been used in monochromators. These are quartz, a positive crystal, calcite, a negative crystal, and ammonium dihydrogen phosphate (PN). Positive means that the index of the extraordinary ray is greater than that of the ordinary ray; in negative crystals the reverse is true.

Calcite is quite soft and cleaves easily into smaller crystals. It is extensively used for Nicol polarizing prisms. Its birefringence is of such an order that a 1/10″ thickness would represent about 2″ of quartz. A piece a few centimeters thick should give a transmission band only a portion of an angstrom wide. Therefore, its important application lies in its use to replace very thick quartz sections in a filter. However, it is very expensive, which places it certainly beyond the means of the average amateur.

Ammonium dihydrogen phosphate has been used in commercially made filters. It is a soft and water-soluble material that works with some difficulty, and the fluid used in polishing must contain no water. The correction for temperature is considerably greater than for quartz. It has about half the birefringence of quartz, and the cost is somewhat less than either calcite or quartz. We believe PN is generally unsuitable for amateur use.

This leaves us with quartz, which is ideal for prominence filters isolating about four angstroms in the red. In calcite, the optical axis makes equal angles with a blunt corner of the crystal. In quartz, as the sketch shows, it is parallel to the sides and is at right angles to the striae on the surfaces. Quartz can be either right-handed or left-handed; one crystal is then the mirror image of the other. This characteristic makes no difference in our filter construction. Remember that the optical axis is not a line but a direction.

Crystal quartz comes mainly from Brazil, where it occurs in a natural state. Before a cut is made it is wise to inspect the crystal carefully so the best portions can be used. The user of a crystal should know what to expect in the way of defects. Even from the best mines in Brazil, it is likely that only one in a hundred of the mined stones is usable. The size of these stones runs from one half to five pounds or from about half a cup to a quart in volume.

The face condition varies from intact to completely eroded away as a result of the quartz having been rolled along a river bed. Such eroded stones are called river quartz, and in them many shallow surface cracks are found. It is more difficult to determine the orientation of a crystal when there is no face intact to give the preliminary orientation.

The best quartz is completely water clear in transparency except possibly for the outside surfaces. Sometimes there is a slight smoky coloration due to traces of impurities. This makes detection of interior defects more difficult. Sometimes a crystal will clear of this smokiness if heated to 450° or 550° C. for a short time.

Electrical and optical twinning are among the most common defects. Twinning is an abnormality of growth in which an apparently homogeneous crystal is not actually oriented the same throughout. Electrical twinning must be determined if the quartz is to be used for piezoelectric plates. It cannot be determined optically. On the other hand, optically twinned quartz may be easily recognized by using polarized light. For our purposes, the optical twinning is important, whereas the electrical twinning is not.

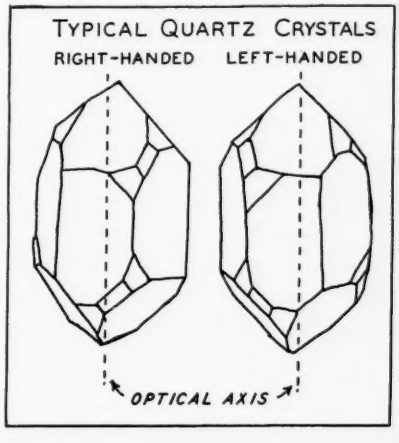
Cracks very often are found in the crystal. Some are so small that they defy discovery because they are finer than the wave length of the light used to look for them. Special care should be used when working quartz to prevent it from being subjected to thermal or mechanical shocks.

The remaining defects may be classified as **inclusions,** which scatter light, but most of them can be tolerated in small quantities. When inclusions are small and closely grouped, they give a bluish cast. The larger the inclusion, the whiter the group appears. Bubbles can occur separately or in fine groups, the latter sometimes referred to as bubble phantom or bubble veil. Sometimes the bubbles are long and thin and are called needle inclusions.

Sometimes stones are so shaped as to make illumination of the interior very difficult. The crystal is then placed in a clear fluid that is of the same refractive index (quartz indices for sodium light are 1.54424 and 1.55335); a suitable substance is mineral oil. Under these conditions all boundaries become invisible and interior defects are easily seen. The interior can then be photographed if desired.

All of the defects of crystal quartz and their detection are treated in great detail in Heising's book, listed in the bibliography last month.

The monochromator aperture need be no larger than 1″, although the author's filter has an aperture 1 3/8″ square. For





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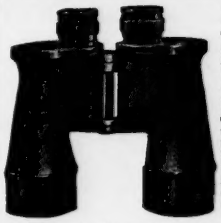

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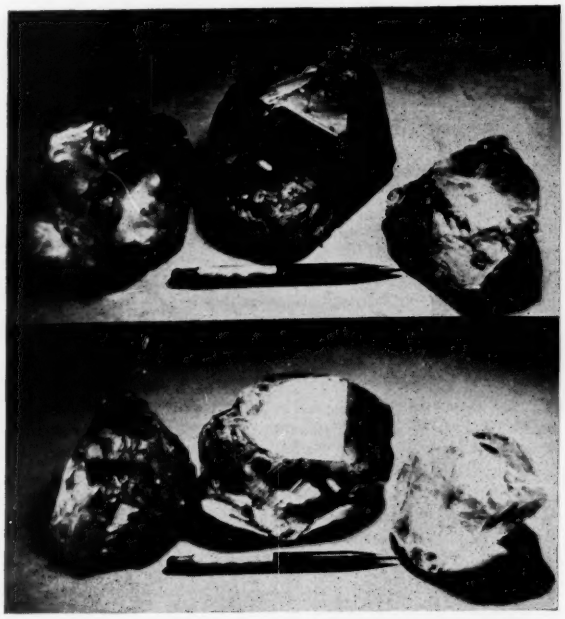
the amateur, square plates are probably quite a good deal easier to make than are circular plates. Some commercially produced filters have an aperture 2" in diameter — with a half band width of about 1½ angstroms. Such filters cost several thousand dollars.

The thickness of the thickest crystal element determines the maximum size of crystal that must be procured, and this, in turn, is the chief factor in the cost of the quartz. As stated last month, there is a certain thickness that should work well for three spectral lines, the H$\alpha$ line, the helium $D_3$ line, and the calcium K line. The thickness would be 2 5/8" for the largest crystal to produce a four-angstrom band at H$\alpha$. The polaroid K 38-40 by all indications just barely works at the K line, where it makes possible a 1.2-angstrom band for the above thickness of quartz. This narrowness results from some of the factors in the equations used in the design changing with wave length; such a band would be sufficiently narrow to see disk features in addition to prominences.

The information in the preceding paragraph should be of interest to all readers, and it may be of special value to those with means and desire to consider the possibility of constructing a filter for these three band locations. Most amateurs, however, who contemplate building a monochromator will be satisfied with following the author's past experience and producing a filter for the H$\alpha$ line only, thereby saving considerable expense and difficulty in construction. The thickest element in the author's filter is 1.8", corresponding to a 4½-angstrom band.

Therefore, at least one quartz crystal must be procured measuring about 2" at right angles to the optical axis. The other crystals may be considerably smaller. Thus, your order should specify at least three rough quartz crystals large enough to cut out interference plates 1.8", 0.9", 0.45", etc., thick at right angles to the optical axis, the plates to be square and at least 1" in cross-section. The quartz must be of grade A, suitable to be used as high-grade interference plates in a quartz polarizing monochromator.

Before it was decided to publish this series of articles, **Sky and Telescope** conducted correspondence with the following suppliers that indicated the general availability of a fair amount of such quartz (not all from one source) at the beginning of this year. Defense mobilization requirements may affect the ease with which



**Two views of the same three pieces of crystal quartz. Compare the shape of the central piece with the sketch on the preceding page. The reproduction is about one third actual size.**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Martin E. Quitt, 149 Broadway, New York 6, N. Y.

Ward's Natural Science Establishment, Inc., P. O. Box 24, Rochester 9, N. Y.

The reader may know of other sources of supply.

These suppliers indicate an average price of about 40 dollars per pound, but the market is very sensitive, as the demand for optical quartz far exceeds the supply. The price per pound varies considerably with the size of the piece, so it is important to decide on your maximum dimensions before ordering. For the largest crystal, a stone of about 1,000 grams would probably be needed, well shaped, of optical quality, free of blue lines, scattered bubbles, and other defects. It would help the supplier if you furnish a sketch similar to that of the monochromator published last month, with the dimensions you choose for each crystal marked right on the sketch. Be sure to mark the direction of the optical axis.

The price is lower for grade A material with less than 100 per cent usability, but which the supplier may be willing to select to give you plates of the right dimensions. Probably such material should be ordered subject to return at the purchaser's expense if it is not usable.

The three crystals pictured with this article were procured recently by the author for 21 and 28 dollars a pound. The largest weighs 2.95 pounds and will produce a 1.5″ square crystal 2.5″ long. The smaller crystals will produce a 1.5″ cube and are suitable for the thinner filter elements. They weigh about 1.5 pounds each. With an assortment of crystals like these, one should be able to cut all the elements needed for the monochromator.

The red glass filters may be procured for a few dollars from Corning Glass Works, Corning, N. Y., or from local dealers. Most suitable are No. 2404 HR Dark Red or No. 2408 HR Signal Red. The 2404 stops transmitting very close to H$\alpha$ and the best of several should be selected. Polaroid is available from the Polaroid Corporation, Cambridge 39, Mass., or from local dealers. It can be obtained either as a sheet or cemented between glass; either works quite well, but the sheet is less expensive. It should be HN 38-40 for red work.

### IMPORTANT NOTE

It was stated on page 149 of the April issue that this monochromator may be attached to amateur-made telescopes, 6-inch reflectors, 4-inch refractors, and larger. In a recent communication to the author, Dr. John W. Evans, of the High Altitude Observatory, whose design we are following in this monochromator, says, "I take exception to your recommendation that the birefringent filter be used with reflectors." Therefore, the amateur should plan to use a refracting telescope or, if one is not available of suitable size, construct a simple coronagraph-type instrument with a nonachromatic lens for the objective. As the filter renders the light essentially monochromatic, the color effects of a one-element objective are not detrimental.

Nor can a coelostat be used with the monochromator. Dr. Evans writes: "I strongly recommend that you do not plan to use a fixed telescope fed by mirrors. I have had a little experience with them in conjunction with a filter like yours, and the results were very disappointing. Apparently, an aluminized or silvered surface has a very strong scatter at small angles to the specular beam. The angle must be extremely small, since the scatter is not very apparent to the naked eye. However, when you use a telescope with a birefringent filter of four or five angstroms passband, you find that the scatter background is so high that only the very brightest prominences show at all."


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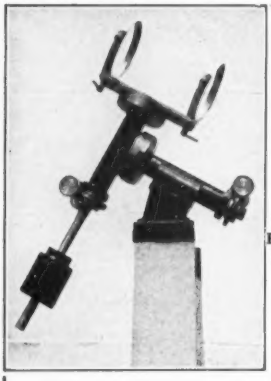

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# OBSERVER'S PAGE

**Universal time is used unless otherwise noted.**

## VISUAL OBSERVING PROGRAMS FOR AMATEURS — XIV

### Observing the Sun

UNLIKE variable star observing, which is an austere activity little likely to attract neighbors to your telescope, solar observing is prone to take on the aspects of a children's party with adults on the outer fringe asking, "Can you tell if it's going to rain tomorrow?"

**Caution! Caution!**

Be sure that neither children nor adults damage their eyes by looking through the finder, which, of course, is not equipped with a solar eyepiece, or by pressing their eyes to the exit rays from the Herschel wedge in the solar eyepiece. Don't leave an unattended, uncapped telescope and finder sitting on a mount in such a location that a youngster can point it toward the sun.

Be sure that your solar eyepiece assembly is entirely safe to use. It is imperative to have at least one reflection off unsilvered glass before allowing the sun's light to reach the dark filter and eyepiece. I have two friends who developed scotomas in their eyes while observing the sun when their dark filters cracked. A scotoma is a burned-out spot or streak on the retina which produces an impression like an intermittent shadow hovering before the eyes.

I have had two dark glasses crack in my own telescopes, when I foolishly omitted the reflection off unsilvered glass because I thought the sun was too low in the sky, in one case, and because I had diaphragmed down my objective in the other. Fortunately, I had stepped back each time so my eye was not damaged, but this was just dumb luck. I have had two crossed polaroids burn out before my eyes, but this change took some minutes so it did not do any damage to my eye.

Of course, if one is studying the sun by projecting its image, the reflection off the unsilvered face of the Herschel wedge is not required.

It would seem needless to caution observers against looking at the sun with the naked eye. But the late Dr. William L. Holt, the AAVSO observer who sent in the millionth observation on variable stars in 1946, told me that he had had at least one patient who had permanently damaged her eyes while looking at a partial eclipse of the sun. So everyone should be cautioned against looking at the sun with the naked eye unless his eyes are shaded by a suitable dark glass or filter of high density.

**Solar Observing Programs.** All the regular observations of the sun which are made by the members of the Solar Division of the AAVSO, under the leadership of its chairman, Neal J. Heines, 560 Broadway, Paterson 4, N.J., may be grouped for convenience into those of a statistical nature, those which deal with manifestations of unusual solar activities, and collateral studies.

Under statistical studies we may include the following: 1. Sunspot counting (including naked-eye groups). 2. Estimation of the granulation of the sun's photosphere. 3. Foreshortening of sunspots. 4. Somewhere midway between statistics and solar activity are the measurements that are being made daily by Mr. Heines and possibly others on the solar constant of radiation. These are made with an electric-eye type of radiation meter.

Under unusual solar activities are: 5. Color in sunspots. 6. Sudden or unusual growth in the activity of any portion of the sun's surface. 7. Studies of possible evidence of rotation in sunspots. 8. Studies of prominences with a monochromator (still in the developmental stage). 9. Somewhere midway between observing unusual solar activities and collateral studies are the reports of aurorae submitted by amateur observers to Donald S. Kimball, chairman of the auroral committee of the AAVSO, Yale Observatory, Prospect and Canner Sts., New Haven 11, Conn.

10. The only collateral study at present deals with migratory birds seen crossing the sun's disk during solar observations.

The backbone of the first three subdivisions of the statistical studies listed above is sunspot counting. The Solar Division has a supply of "Instructions for Reporting Visual Sunspot Observations" which describe this procedure.

Let me warn you, however, that these observations are not easy to make. Don't think you can go out and count sunspots as you would roses in your garden. Before you can count sunspots intelligently, you must have some idea of the diversity of appearance which spots, and especially groups, may present, and you must learn to orient the sun so that you know where east, west, north, south, and the solar equator lie. In addition, as will become apparent from our discussion below, while the casual observer of variable stars

**The 3-inch refractor which David W. Rosebrugh uses for counting sunspots.**

can and often does contribute observations of use, only the regular and reliable sunspot observer is of value in the Solar Division program.

Great statistical reliability is required, and your observations at first will be used merely for establishing your reliability weighting, $W_i$, and your observatory constant, $K_i$ (i means individual). There is some evidence that a new observer needs about three years of experience before his counts become reliable statistically. At present the apprenticeship time is four months, but it is planned to lengthen this period. There may be an opportunity for very useful study here for anyone who is statistically inclined, to help in the problems that face the determination of the American sunspot number.

As is well known, Schwabe was the first person to establish the periodicity of the sunspot cycle, working from 1826 to 1857. R. Wolf, of Zurich, carried forward this work, using a 3-inch refractor and a power of 64, until his death in 1893. Wolf also used old records to carry back the sunspot number to 1745 with some completeness and to 1610 using such records as were available. Since Wolf's death, Wolfer, Brunner, and Waldmeier have carried this work forward and have established the Zurich sunspot number, $R_Z$, as the standard for the world. It will be noted, therefore, that the Zurich sunspot number is largely based upon the work of one observatory with a continuing tradition and practice.

It seems, however, in the present uncertain state of the world, that scientists should not be dependent upon one source alone for so important an index of the sun's activity. Starting in 1944 an American sunspot number, $R_A$, has been derived from observations by amateurs in the Western Hemisphere, although Zurich's observations are included also in the observations upon which the number is based. Like all lusty youngsters, $R_A$ has suffered from the troubles of childhood, the chief of which is that it is based, not upon the work of a few observers with a tradition, but upon the work of many amateurs without tradition, and in the beginning without much experience. Their work has thus far been blended into a whole by statistical means at the Central Propagation Laboratory of the National Bureau of Standards in Washington, D.C.

The principle is considered to be sound, but the American number has considerably exceeded the Zurich number, by what is now as much as 33 per cent. The reason for this is not clearly known. Perhaps the base period which was used, namely, the last six months of Brunner's observing lifetime in 1944-1945, in an effort to make $R_A$ carry on the tradition of Brunner's work on $R_Z$, was not a suitable period. This overlapping period unfortunately occurred near sunspot minimum. It seems to the writer, however, that it is more likely that the American amateur observers, who form the principal contributors toward the determination of the American number, gradually improve their observing techniques, and perhaps their equipment, during the first three to five years, after which they become statistically reliable. During this entire period the individual's visual acuity is probably rising.

This problem confronts the Solar Division at present, and if any statisticians wish to come forward and solve it, and perhaps recalculate the American number back to its inception in 1944, they will be serving a worthwhile purpose.

It has been concluded recently by the Solar Division head and his technical advisers that for purposes of statistical reliability all observers should employ as nearly as possible the same instrumental means that Wolf used, and it is suggested that new observers, at least, equip themselves with instruments answering as nearly as possible the following specifications: A 3-inch refractor, or a larger one diaphragmed down to three inches, with a solar eyepiece in which there is one reflection off unsilvered glass, a dark glass consisting of a Willson Products, Inc., Reading, Pa., atomic hydrogen welding goggle glass, No. 10, 12, or 14, and an eyepiece giving a power of 64.

Once having started on an observing program, do not change your observing equipment without notifying Solar Division headquarters. This applies for the statistical programs, sunspot counting, granulation, foreshortening, and bird observations. For other purposes you can use what equipment you prefer.

DAVID W. ROSEBRUGH
79 Waterville St.
Waterbury 10, Conn.

## PHASES OF THE MOON

| | | | |
|---|---|---|---|
| New moon | May | 6, | 1:35 |
| First quarter | May | 14, | 5:32 |
| Full moon | May | 21, | 5:45 |
| Last quarter | May | 27, | 20:17 |
| New moon | June | 4, | 16:40 |

| | May | Distance | Diameter |
|---|---|---|---|
| Apogee | 9, 17h | 252,200 mi. | 29′ 27″ |
| Perigee | 22, 4h | 222,700 mi. | 33′ 20″ |
| | June | | |
| Apogee | 6, 1h | 252,600 mi. | 29′ 24″ |

## SOLAR ECLIPSE REPORTS

The partial eclipse of the sun on March 7th was well observed, with weather very favorable over wide sections of the country. About 150 persons gathered in Cole Park in Dallas to use instruments set up by the Texas Astronomical Society. The Dallas **Morning News** published photographs taken through one of the telescopes, according to a report from E. M. Brewer, president of the group.

In Biloxi, Miss., William T. Williams timed the 40-per-cent eclipse, making naked-eye observations, and noting that there was no radio static of any type at any time during the eclipse. G. R. Staples used a solar eyeshade for observing from Portsmouth, Va., as the sun was too low to warrant using a telescope. Clouds obscured the sky in New England.

In Rochester, members of the astronomy club observed and photographed the event from scattered sections of the city during the rush hour. Paul W. Stevens reports having "the best view in town from the roof of the seven-story Kodak plant," where he took experimental pictures in preparation for the sunrise eclipse on September 1st. The Rochester **Democrat and Chronicle** published a view through trees of the notched setting sun; it was taken through a 5¼-inch telescope, stopped down to a 3/4-inch opening, exposure time 1/1,000 second. The flattening of the sun by refraction amounted to five per cent of its diameter. The photograph was taken by Paul Davis.


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## DEEP-SKY WONDERS

THE VISIBILITY of galaxies is always an interesting problem, and this month we suggest three objects in Leo Minor, all close together in the sky, and with different magnitudes. The writer will be interested in hearing from amateurs on the difficulty of seeing each of these in various sized telescopes (including their finders).

| Designation | | | R.A. | Dec. | Mag. | Size | Type |
|---|---|---|---|---|---|---|---|
| NGC | 3414 | $36^2$ | $10^h\ 48^m.6$ | +28° 15′ | 12.2 | 1′.8 ... | SBb |
| NGC | 3504 | $88^1$ | $11^h\ 00^m.5$ | +28° 15′ | 11.7 | 2′.0 x 1′.0 | SBb |
| NGC | 3486 | $87^1$ | $10^h\ 57^m.8$ | +29° 15′ | 11.4 | 3′.8 ... | Sc |

Does the difference in brightness seem comparable to their listed difference in magnitude? How does magnification affect their visibility? Does the total light seem equivalent to that of a star of the same magnitude? Try expanding a star out of focus until it is the same diameter as the galaxy (that is, compare the object in focus with a star out of focus).

If you write in, be sure to give the diameter of your lens or mirror and of your finder, and the exact power used.

The three objects are all plotted in Norton's **Star Atlas,** but are not on the Beyer-Graff. They appear in the Skalnate Pleso **Atlas,** which shows a number of other galaxies in the area. They are all listed in Smyth's **Celestial Cycle,** but are not included by Webb.

The information below is from the Shapley-Ames catalogue, and gives 1950 co-ordinates.

Send your comments to 811 N. Fifth, St. Charles, Mo. The results will be noted in this column in a future issue.

WALTER SCOTT HOUSTON

## OCCULTATION PREDICTIONS

April 30-May 1 **Phi Aquarii** 4.4, *23*:11.8 −6-18.8, 24, Im: **A** 9:08.5 −0.7 +1.8 69; **C** 8:59.4 −0.6 +1.7 72. Em: **A** 10:16.1 −0.9 +2.0 226; **C** 10:04.9 −0.8 +2.0 225.

May 14-15 **Rho Leonis** 3.8, 10:30.2 +9-33.6, 9, Im: **G** 6:31.8 −0.6 −1.9 113; **H** 6:57.7 −0.4 −2.1 137; **I** 6:28.5 −0.7 −1.9 124. Em: **H** 8:00.2 −0.3 −1.6 292.

May 17-18 **Psi Virginis** 4.9, 12:51.8 −9-16.4, 12, Im: **B** 6:06.4 −0.7 −1.8 125; **D** 6:04.9 −0.9 −1.9 129; **E** 6:00.8 −1.0 −1.8 141; **F** 6:13.9 −0.8 −2.6 165; **G** 5:21.6 −0.7 −1.4 158; **I** 5:19.6 −0.1 −1.8 177. Em: **E** 7:06.3 −0.9 −1.5 282; **F** 7:09.1 −1.5 −0.9 263.

June 7-8 **Kappa Geminorum** 3.7, 7:41.5 +24-31.0, 3, Im: **B** 1:39.4 +0.4 −1.8 126; **D** 1:45.0 +0.4 −2.0 135; **E** 1:58.9 +0.7 −2.6 158. Em: **E** 2:39.1 −0.4 −0.8 245.

**For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.**

**The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.**

Longitudes and latitudes of standard stations are:

| | | | |
|---|---|---|---|
| **A** | +72°.5, +42°.5 | **E** | +91°.0, +40°.0 |
| **B** | +73°.6, +45°.6 | **F** | +98°.0, +31°.0 |
| **C** | +77°.1, +38°.9 | **G** | +114°.0, +50°.9 |
| **D** | +79°.4, +43°.7 | **H** | +120°.0, +36°.0 |
| | | **I** | +123°.1, +49°.5 |

## VARIABLE STAR MAXIMA

May 4, R Andromedae, 7.0, 001838; 6, V Coronae Borealis, 7.4, 154639; 11, V Ophiuchi, 7.5, 162112; 13, S Hydrae, 7.9, 084803; 13, T Hydrae, 7.7, 085008; 15, S Gruis, 7.8, 221948; 18, RV Sagittarii, 7.8, 182133; 20, R Bootis, 7.3, 143227; 23, R Lyncis, 7.9, 065355; 25, S Virginis, 7.1, 132706. June 2, T Columbae, 7.6, 051533; 6, X Centauri, 7.8, 114441; 7, X Ophiuchi, 6.9, 183308.

**These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).**

## MINIMA OF ALGOL

May 1, 10:01; 4, 6:50; 7, 3:39; 10, 0:28; 12, 21:17; 15, 18:06; 18, 14:55; 21, 11:44; 24, 8:33; 27, 5:22; 30, 2:11. June 1, 23:00; 4, 19:48; 7, 16:37.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope,** Vol. VII, page 260, August, 1948, for further explanation.

## MAY METEORS

The Eta Aquarid meteor shower may be favorably observed from May 4th to 6th. Up to 10 meteors per hour should be counted in the pre-dawn sky. This shower is associated with Halley's comet, and is perhaps connected to the daylight Piscid stream observed by radar.

E. O.

## UNIVERSAL TIME (UT)

**TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.**

# Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.

SCHEDULE: Tuesday thru Friday at 3:30 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. In charge, Charles A. Federer, Jr.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

SCHEDULE: Wednesday and Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

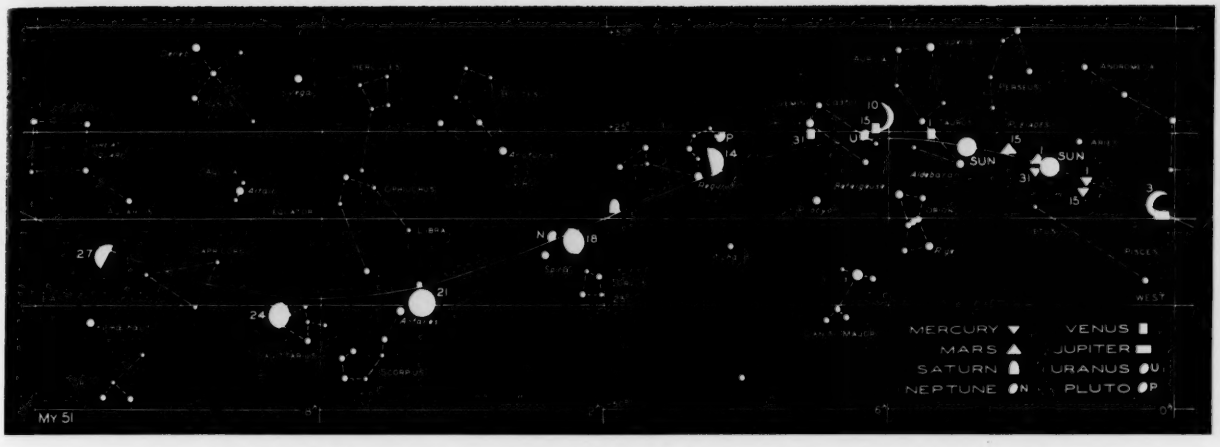
SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.




### THE SUN, MOON, AND PLANETS THIS MONTH

**The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown.**

**Mercury** will be in the morning sky all month, reaching greatest elongation on May 22nd. Although the planet is 25° 24′ west of the sun at elongation, it will rise only one hour before sunrise and will be rather difficult to view.

**Venus** continues its brilliant evening apparition and is now visible for 3½ hours after sunset. The rapid motion of the planet carries it from Taurus through Gemini, at its northernmost declination this year. Telescopically, Venus presents a disk 16 seconds of arc in diameter with 69 per cent of the planet illuminated on the 15th.

**Mars** enters the morning sky on May 22nd, passing conjunction with the sun, and will not be visible until summer.

**Jupiter** leaves the morning twilight zone in mid-May, rising at the east point of the horizon two hours before the sun.

**Saturn** remains visible through the night, favorably situated for observation. It appears as a yellowish "star" of 1st magnitude, located 2° north of Beta Virginis and virtually stationary all month.

The Saturnian ring system is more nearly edge on than at any time since last autumn. On May 25th, the inclination is slightly over 1°, the minimum angle for the next 14 years. The major diameter is 41″ compared to the minor of 0″.74, and the rings appear like a needle of light on either side of the disk.

**Uranus** may be observed with field glasses for a short time after sunset low in the west. The planet will be in conjunction with Venus on May 17th, Venus passing 2° 5′ north. Note that Venus outshines Uranus by nearly 10,000 times, as there is a difference of nearly 10 magnitudes. Uranus is moving eastward nearly equidistant from Mu and Epsilon Geminorum.

**Neptune,** well placed, transits at 9:30 p.m. local time. On May 1st, the planet is 4′ south of Theta Virginis; this conjunction will be visible in moderate-sized binoculars. For the remainder of the month Neptune will move westward from Theta.

E. O.

### HALO OBSERVATIONS WANTED

The report on halo photography in the April issue (page 141) was very interesting. Some of your readers may wish to know that I am collecting the results of halo observations, and persons making such observations or wanting to do so may get in touch with me.

No instruments are required, only a little attention, a pocket watch or wrist watch, a pencil, and a small book for noting the time and kind of observed halo.

HERBERT A. LUFT
42-10 82nd St.
Elmhurst, N. Y.

### PREDICTIONS OF BRIGHT ASTEROID POSITIONS

| No. 14 | Irene | | Mag. 9.2 | |
|---|---|---|---|---|
| | h | m | ° | ′ |
| May 14 | 17 | 18.2 | −18 | 15 |
| 24 | 17 | 09.9 | −18 | 41 |
| June 3 | 16 | 59.9 | −19 | 09 |
| 13 | 16 | 49.7 | −19 | 38 |
| 23 | 16 | 40.5 | −20 | 08 |
| July 3 | 16 | 33.3 | −20 | 38 |
| **No. 2** | **Pallas** | | **Mag. 9.3** | |
| | h | m | ° | ′ |
| June 23 | 20 | 15.9 | +19 | 32 |
| July 3 | 20 | 09.6 | +19 | 38 |
| 13 | 20 | 02.1 | +19 | 20 |
| 23 | 19 | 54.1 | +18 | 35 |
| Aug. 2 | 19 | 46.3 | +17 | 25 |
| 12 | 19 | 39.2 | +15 | 53 |

The above are predicted positions in right ascension and declination for the epoch 1951.0, for 0h Universal time. The magnitude is that expected at opposition. In each case the motion of the asteroid is retrograde.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WANTED: Good sturdy tripod about 50 inches high with, or without, equatorial head for mounting a 4″ refractor. P. O. Parker, 304 W. Solomon St., Griffin, Ga.

BLUEPRINTS of the moon: Eight 8 x 10 maps showing the moon in progressive phases, with names of over 300 features. Three index sheets. Ideal for small telescopes. $2.00 postpaid. Northwood Observatory, 4102 Westview Rd., Baltimore 18, Md.

NORTON'S "Star Atlas and Reference Handbook," latest edition, 1950, $5.25 postpaid. "Atlas Celeste," International Astronomical Union's official atlas to magnitude 6.0, $2.55. "Bonner Durchmusterung," moon maps, and other foreign publications. Ask for information. Herbert A. Luft, 42-10 82nd St., Elmhurst, N. Y.

FAILING EYESIGHT at 80 compels sacrifice of professionally made 7″, f/14 refractor in tapered wooden barrel; equatorially mounted on heavy steel frame; manually driven by worm gears and clamp; both circles but no finder 'scope; five eyepieces. $400.00. L. L. Rice, Ware Neck, Va.

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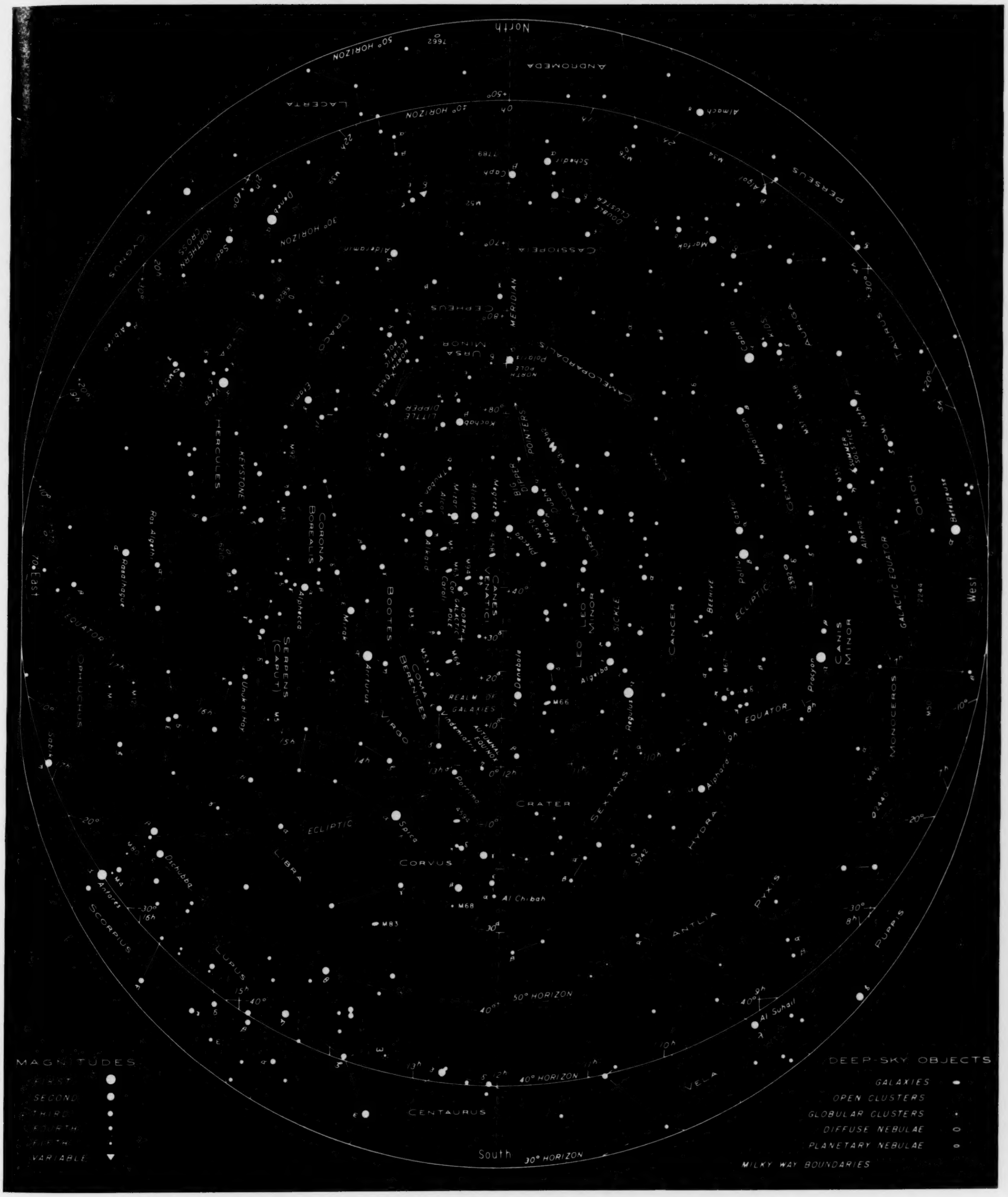
FOR SALE: Mounted 5″ and 6″ refractor objectives of first quality, $200.00 and $300.00. Correspondence invited. Earl Witherspoon, Sumter, S. C.

# HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

| *State* | *City* | *Organization* | *Time* | *Meeting Place* | *Communicate With* |
|---|---|---|---|---|---|
| ALABAMA | Gadsden | Ala. A.A. | 7:30, 1st Thu. | Ala. Power Audit. | Brent L. Harrell, 1176W or 55 |
| ARIZONA | Phoenix | *Phoenix Obs. Ass'n. | 8:00, 1st, 3rd Tue. | Phoenix College | Paul E. Griffin, 1708 S. 3rd St. |
| CALIFORNIA | Los Angeles | L.A.A.S. | 7:45, 2nd Tue. | Griffith Obs. | H. L. Freeman, 853½ W. 57 St. |
| | Norwalk | *Excelsior Tel. Club | 7:00, Thu. | Excelsior Union H.S. | Geo. F. Joyner, 12008 E. Sproul St. |
| | Oakland | *Eastbay A.S. | 8:00, 1st Sat. | Chabot Obs. | Miss A. Roemer, 1556 Everett, Alameda |
| | Palo Alto | *Peninsula A.S. | 7:30, 1st Fri. | Community Center | H. W. Milner, 350 Tennyson Ave. |
| | Sacramento | *Sac. Val. A.S. | 8:00, 1st Tue., bi-mon. | Sacramento College | Mrs. E. Champ, 3816 Sacramento Blvd. (17) |
| | San Diego | Ast. Soc. of S.D. | 7:30, 1st Fri. | 504 Electric Bldg. | W. T. Skilling, 3140 Sixth Ave. |
| | San Diego | A.T.M. Ast. Club | 7:30, 2nd, 4th Mon. | 3121 Hawthorn St. | G. A. Sharpe, 4477 Muir, Bayview 3757 |
| | Stockton | *Stockton A.S. | 8:00, 2nd Mon. | Stockton College, P-11 | W. A. Craig, 1043 W. Park |
| COLORADO | Denver | *Am. Tel. Cl. of Den. | 8:00, 2nd, 4th Mon. | Chamberlin Obs. | W. E. Johnson, 264 S. Gilpin St. |
| CONNECTICUT | Middletown | Centr. Conn. A.A. | 8:00, 1st Tue. | Van Vleck Obs. | Walter Fellows, Middle Haddam |
| | New Haven | †A.S. of New Haven | 8:00, 4th Sat. | 320 York St. | Mrs. Helen Velardi, 437 Wash., N'th Haven |
| | Norwalk | Norwalk A.S. | 8:00, Last Fri. | Private houses | Mrs. A. Hamilton, 4 Union Pk., 6-5947 |
| | Stamford | Stam. Museum A.A. | 8:00, 3rd Fri. | Stamford Museum | R. F. Ives, Post Rd. East, Darien |
| DIST. COL. | Washington | †Nat'l. Cap. Ast'mers | 8:00, 1st Sat. | Comm. Dept. Audit. | Janet Perkins, 2141 Eye St. NW (7), RE 7676 |
| FLORIDA | Daytona Beach | D. B. Stargazers | 8:00, Alt. Mon. | 105 N. Halifax Ave. | Wm. T. Thomas, 105 N. Halifax |
| | Jacksonville | *J.A.A.C. | 8:00, 1st, 3rd Mon. | Private homes | E. L. Rowland, Jr., 442 St. James Bldg. |
| | Key West | †Key West A.C. | 8:00, 1st Wed. | Private homes | W. M. Whitley, 1307 Div. St., 724-R |
| | Miami | South'n Cross A.S. | 7:30, Every Fri. | M. B. Lib. Grounds | A. P. Smith, Jr., 426 S.W. 26 Rd. |
| GEORGIA | Atlanta | †*Atlanta A.C. | 7:30, 2nd Fri. | Agnes Scott College | W. H. Close, 225 Forkner Dr., Decatur |
| ILLINOIS | Chicago | †*Burnham A.S. | 4:00, 2nd Sun. | Adler Planetarium | Wm. Callum, 1435 Winona St. |
| | Geneva | *Fox Valley A.S. | 8:00, 1st Tue. | Geneva City Hall | Joseph Zoda, 501 S. 6th St., St. Charles |
| | Moline | †*Popular A.C. | 7:30, Wed. | Sky Ridge Obs. | Carl H. Gamble, 3201 Coaltown Rd. |
| INDIANA | Indianapolis | †Indiana A.S. | 2:15, 1st Sun. | Riley Library | Clark B. Hicks, 305 Ruckle St. |
| KANSAS | Topeka | *Topeka A.A.S. | 7:30, 2nd Mon. | Topeka H.S. | Miss N. Utschen, 1607 Wayne Ave. |
| | Wichita | †*Wichita A.S. | 8:00, 1st Wed. | ..... | Dollie Ratcliff, 801 Maple, 2-1822 |
| KENTUCKY | Louisville | †L'ville A.S. | 8:00, 1st Tue. | Univ. of Louisville | B. F. Kubaugh, 621 34th St. |
| | Owensboro | *Owensboro A.C. | 8:00, 3rd Sat. | Public Library | Hermann Batt, 1507 Hathaway St. |
| LOUISIANA | New Orleans | A.S. of N.O. | 8:00, Last Wed. | Cunningham Obs. | Dr. J. Adair Lyon, 1210 Broadway |
| MAINE | Portland | †A.S. of Maine | 8:00, 2nd Fri. | Private homes | H. Harris, 27 Victory Ave., S. Portland |
| MASSACHUSETTS | Cambridge | †*Bond A.C. | 8:15, 1st Thu. | Harvard Obs. | C. A. Federer, Jr., Harvard Observatory |
| | Cambridge | †*A.T.M.s of Boston | 8:00, 2nd Thu. | Harvard Obs. | H. Smith, 26 Kingman St., Weymouth, 9-3438-R |
| | Springfield | †*S'field Stars | 8:00, 2nd Wed. | Private homes | F. D. Korkosz, Mus. Nat. Hist., 2-4317 |
| | Worcester | †*Aldrich A.S. | 7:30, 1st, 3rd Tue. | Mus. Natural Hist. | Ralph A. Wright, 4 Mason St. |
| MICHIGAN | Ann Arbor | †Ann Arbor A.A.A. | 7:30, 2nd Mon. | U. of Mich. Obs. | Stewart W. Taylor, 1106 Birk Ave. |
| | Battle Creek | †B. C. A.A. Club | 8:00, 2nd Fri. | Kingman Museum | Mrs. W. V. Eichenlaub, 47 Everett St. |
| | Detroit | †*Detroit A.S. | 3:00, 2nd Sun. | Wayne U., State Hall | E. R. Phelps, Wayne University |
| | Detroit | †*N.W. Detroit A.S. | 8:00, 1st Tue. | Redford H. S. | John W. Broxholm, 16596 Chapel St. (19) |
| | Kalamazoo | †Kalamazoo A.A.A. | 8:00, Sat. | Private homes | Mrs. G. Negrevski, 2218 Amherst, 31482 |
| | Lansing | †*Lansing A.A. | 8:00, 1st, 3rd Wed. | Technical H. S. | Mrs. T. A. Louden, 940 Bensch St. (14) |
| | Pontiac | †*Pontiac A.A.A. | 8:00, 3rd Sun. | Cranbrook Inst. | Mrs. M. Chircop, 147 Prospect St., 21455 |
| MINNESOTA | Duluth | †*Darling A.C. | 8:00, 1st, 3rd Fri. | Darling Obs. | Mrs. A. Lynch, 1911 Wisconsin. Superior, Wis. |
| | Minneapolis | M'polis A.C. | 7:30, 1st, 3rd Wed. | Public Library | Jane Simmer, 2406 Clinton Ave. S. |
| | St. Paul | *St. Paul Tel. Club | 7:30, 2nd, 4th Wed. | Macalester Coll. | Mrs. H. Wolcott, 1705 Scheffer Ave.•(5) |
| MISSOURI | Fayette | †*Central Mo. A.A. | 7:30, Last Sat. | Morrison Obs. | R. C. Maag, 611 Bluff St., Fulton |
| | Kansas City | †*A.A. & T.M.s | 8:00, 4th Sat. | Private homes | Reginald Miller, Merriam, Kans. |
| | St. Louis | †*St. Louis A.A.S. | 8:00, 3rd or 4th Sat. | Inst. of Tech., St. L. U. | S. O'Byrne, 501 E. Pacific, Webster Groves 19 |
| NEVADA | Reno | A.S. of Nev. | 8:00, 4th Wed. | Univ. of Nevada | E. W. Harris, University of Nevada |
| NEW JERSEY | Caldwell | West Essex A.A. | 8:00, 2nd Mon. | Caldwell Mun. Bldg. | D. C. Smith, 19 Francisco Ave., W. Caldwell |
| | Jersey City | †Revere Boys Club | 7:15, Mon., Tue. | Gregory Mem. Obs. | Enos F. Jones, 339 Wayne St. |
| | Roselle Park | A.A.S. of Union Co. | ...., 4th Fri. | Boro Hall | Mrs. R. N. Bochau, 236 Normandy V.ll., Union |
| | Teaneck | †Bergen Co. A.S. | 8:30, 2nd Wed. | Obs., 107 Cranford Pl. | J. M. Stofan, 332 Herrick |
| NEW YORK | Buffalo | †*A.T.M.s & Observers | 7:30, 1st, 3rd Wed. | Mus. of Science | Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga |
| | Gloversville | †A.C. of Fulton Co. | .... | ..... | L. R. Ogden, 60 W. Pine St. |
| | New York | *A.A.A. | 8:00, 1st Wed. | Amer. Mus. Nat. Hist. | G. V. Plachy, Hayden Plan., EN 2-8500 |
| | New York | †Junior A.C. | 7:30, 4th Fri. | Amer. Mus. Nat. Hist. | J. Rothschild, Hayden Plan., EN 2-8500 |
| | Rochester | †Rochester A.C. | 8:00, Alt. Fri. | Rochester Museum | H. O. Woodard, 485 Hayward Ave. (9) |
| | Schenectady | †*S'tady A.C. | 8:00, 2nd Mon. | Schenectady Museum | C. E. Johnson, 102 State St. |
| | Troy | *Renss. Ap. Soc. | 7:30, Alt. Tue. | Sage Lab., R.P.I. | S. J. Lukasik, 31 Belle Ave. |
| | Utica | †*Utica A.A.S. | 7:30, 4th Tue. | Proctor Inst. | John Zimm, 239 Thieme Pl. |
| | Wantagh | Long Island A.S. | 8:00, Sat. | Private homes | A. R. Luechinger, Seaford Ave., 1571 |
| N. CAROLINA | Greensboro | †*Greensboro A.C. | 8:00, 1st Thu. | Woman's Coll., U.N.C. | Mrs. Z. V. Conyers, 210 W. Fisher Ave. |
| | Raleigh | †Astronomical Soc. | .... | N. C. State Coll. | C. F. Campen, Jr., Physics Dept. |
| | Winston-Salem | †*Forsyth A.S. | 7:30, Last Fri. | Private homes | Kenneth Shepherd, 1339 W. 4th St. |
| OHIO | Akron | *A.C. of Akron | 8:00, 2nd Fri. | Beth.-Luth. Church | Mrs. R. J. Couts, 878 Kennebec Ave. (5) |
| | Cincinnati | *Cin. A.A. | 8:00, Various days | Cincinnati Obs. | Robert Berkmeier, 2432 Ohio Ave. |
| | Cincinnati | *Cin. A.S. | 8:00, 3rd Wed. | 5556 Raceview Ave. | John Dann, 3318 Felicity Dr. (11) |
| | Cleveland | †Cleveland A.S. | 8:00, Fri. | Warner & Swasey Obs. | Mrs. A. Townhill, Warner & Swasey Obs. |
| | Columbus | *Columbus A.S. | 8:00, 2nd Fri. | McMillin Obs. | J. A. Hynek, Ohio State Univ. |
| | Dayton | A.T.M.s of Dayton | Eve., 3rd Sat. | Private homes | F. E. Sutter, RR 7, Box 253A (9) |
| | Lorain-Elyria | *Black River A.S. | 8:00, 2nd Mon. | Clearview School | Louis Rick, Box 231, Lorain |
| | Marietta | Marietta A.S. | Irregular | Cisler Terrace | Miss L. E. Cisler, Cisler Terrace |
| | Toledo | Toledo Ast. Club | ...., 3rd Tue. | Univ. of Toledo Obs. | E. D. Edenburn, 4124 Commonwealth Ave. |
| | Warren | Mahoning Val. A.S. | 8:00, Thu. | Private homes | S. A. Hoynos, 1574 Sheridan, NE, 25034 |
| | Youngstown | *Y'town A.C. | 7:30, 1st Fri. | Homestead Pk. Pav'n. | F. W. Hartenstein, 905 Brentwood |
| OREGON | Portland | †*Portland A.S. | 8:00, 1st Mon. | Planetarium | H. J. Carruthers, 427 S. E. 61 Ave. |
| | Portland | †A.T.M. & Observers | 8:00, 2nd Tue. | Mus. of Sci. and Ind. | N. C. Smale, 831 N. Watts St. |
| PENNSYLVANIA | Beaver | †*Beaver Co. A.A.A. | 8:00, 4th Tue. | Com'y Bldg., Tamaqui | Mrs. R. T. LuCaric, Box 463, Baden |
| | Millvale | A.A.A. Shaler T'ship | 8:00, 3rd Fri. | Cherry City Fire House | Cliff Raible, Rebecca Sq. (9) |
| | Philadelphia | †A.A. of F.I. | 8:00, 3rd Fri. | Franklin Institute | Edwin F. Bailey, RIT 3050 |
| | Philadelphia | *Rittenhouse A.S. | 8:00, 2nd Fri. | Morgan Physics, U. Pa. | Sarah Lippincott, Sproul Obs., Swarthmore |
| | Pittsburgh | †*A.A.A. of P'burgh | 8:00, 2nd Fri. | Buhl Planetarium | G. Winterhalter, 5-J Terrace, McKees Rocks |
| RHODE ISLAND | Providence | Skyscrapers, Inc. | 8:00, Mon. or Wed. | Ladd Observatory | Ladd Obs., Brown U., Jackson 1-5680 |
| S. CAROLINA | Columbia | North'n Cross A.S. | 8:15, Every Mon. | Melton Observatory | Dr. L. V. Robinson, Univ. of S. C. |
| TENNESSEE | Chattanooga | *Barnard A.S. | 8:00, 3rd Fri. | Jones Observatory | C. T. Jones, 302 James Bldg., 7-1936 |
| | Nashville | *Barnard A.S. | 7:30, 2nd Thu. | Vanderbilt Univ. | Miss J. Saffer, 446 Humphrey St. (10) |
| TEXAS | Dallas | †Texas A.S. | 8:00, 4th Mon. | Various auditoriums | E. M. Brewer, 5218 Morningside, U6-3894 |
| | Ft. Worth | †*Ft. Worth A.S. | 8:00, 4th Fri. | Texas Christian U. | L. C. Eastland, 5501 Byers Ave. (7) |
| | Houston | Houston A.S. | 7:30, Last Fri. | Mus. Nat. Hist. Annex | Mrs. J. Murray, 1007 W. Gray (6) |
| | Port Arthur | †*Port Arthur A.C. | ...., 2nd Tue. | Private homes | G. van den Berg, Box 266, Groves |
| UTAH | Salt Lake City | †*A.S. of Utah | 8:00, 2nd Fri. | City and County Bldg. | Junius J. Hayes, 1148 East 1 S. |
| VERMONT | Springfield | Springfield T.M.s | 6:00, 1st Sat. | Stellafane | John W. Lovely, 27 Pearl St., 535-W |
| VIRGINIA | Norfolk | †*A.A.S. of Norfolk | 8:00, 2nd, 4th Thu. | Museum of Arts | A. Hustead, U.S. Weather Bureau, 21745 |
| | Richmond | †*Richmond A.S. | 8:00, 1st Tue. | Builders Exchange | Miss L. Sievers, 4018 Clinton Ave. (27) |
| WASHINGTON | Spokane | *A.T.M.s of Spokane | .... | ..... | D. K. Johnson, 301 S. 15th, Coeur d'Alene, Id. |
| | Tacoma | Tacoma A.A. | 8:00, 1st Mon. | Coll. of Puget Sd. | Dorothy E. Nicholson, 2816 N. Union Ave. |
| | Yakima | †*Yak. Am. Ast'mers | 8:00, 2nd Mon. | Cha. of Comm. Bldg. | Edward J. Newman, 324 W. Yakima Ave. |
| WISCONSIN | Beloit | Beloit A.S. | ...., 1st, 3rd Thu. | YMCA Bldg. | Kenneth W. Schultz, 959 Johnson St. |
| | Madison | †Madison A.S. | 8:00, 2nd Wed. | Washburn Obs. | Dr. C. M. Huffer, Washburn Obs. |
| | Milwaukee | †*Milw. A.S. | 8:00, 2nd Mon. | Public Museum | E. A. Halbach, 2971 S. 52 St., W. Allis |



**The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of May, respectively.**

## STARS FOR MAY

A SHOWCASE of spectral types is Corvus, the Crow, best situated for northern observers during May. Gamma, or Gienah, is the brightest star in the constellation, and leads the spectral parade as a blue-white **B**-type star. To the east, Delta (δ) represents the **A**-type stars.

Al Chibah, the star below the southwest corner of the quadrilateral, is type **F**, similar to Procyon, a considerably brighter member of this class still visible in the western evening skies. Although labeled α, Al Chibah places only fifth in order of brightness of the Corvus stars. Beta, just 0.06 of a magnitude fainter than Gamma, is next in the spectral sequence, typifying type **G.** Finally, Epsilon (ε) belongs in the cooler Arcturus-type classification, **K,** of an orange hue.

To complete our series with a cool **M** star, we can move to the rambling group just north and east of Corvus, where δ Virginis satisfies our demands. Although both Spica and the region of galaxies in Virgo and Coma are well known, fewer amateurs have taken time to trace out the extended and not too esthetic figure of Virgo. Bayer represents her with wings, flowing tresses, and a palm branch; any similarity to the pattern of the Virgo stars in the sky is purely coincidental. O. G.